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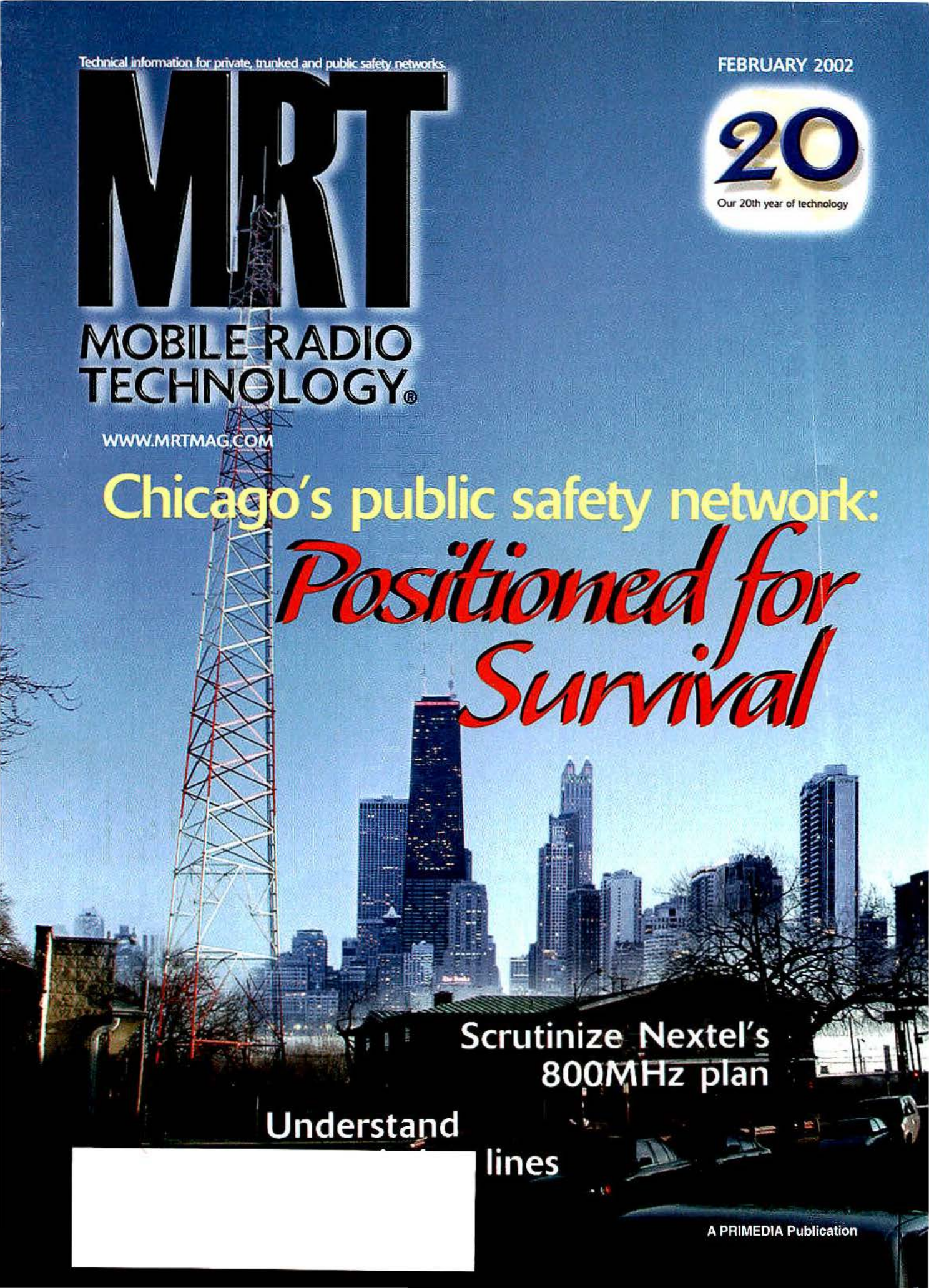

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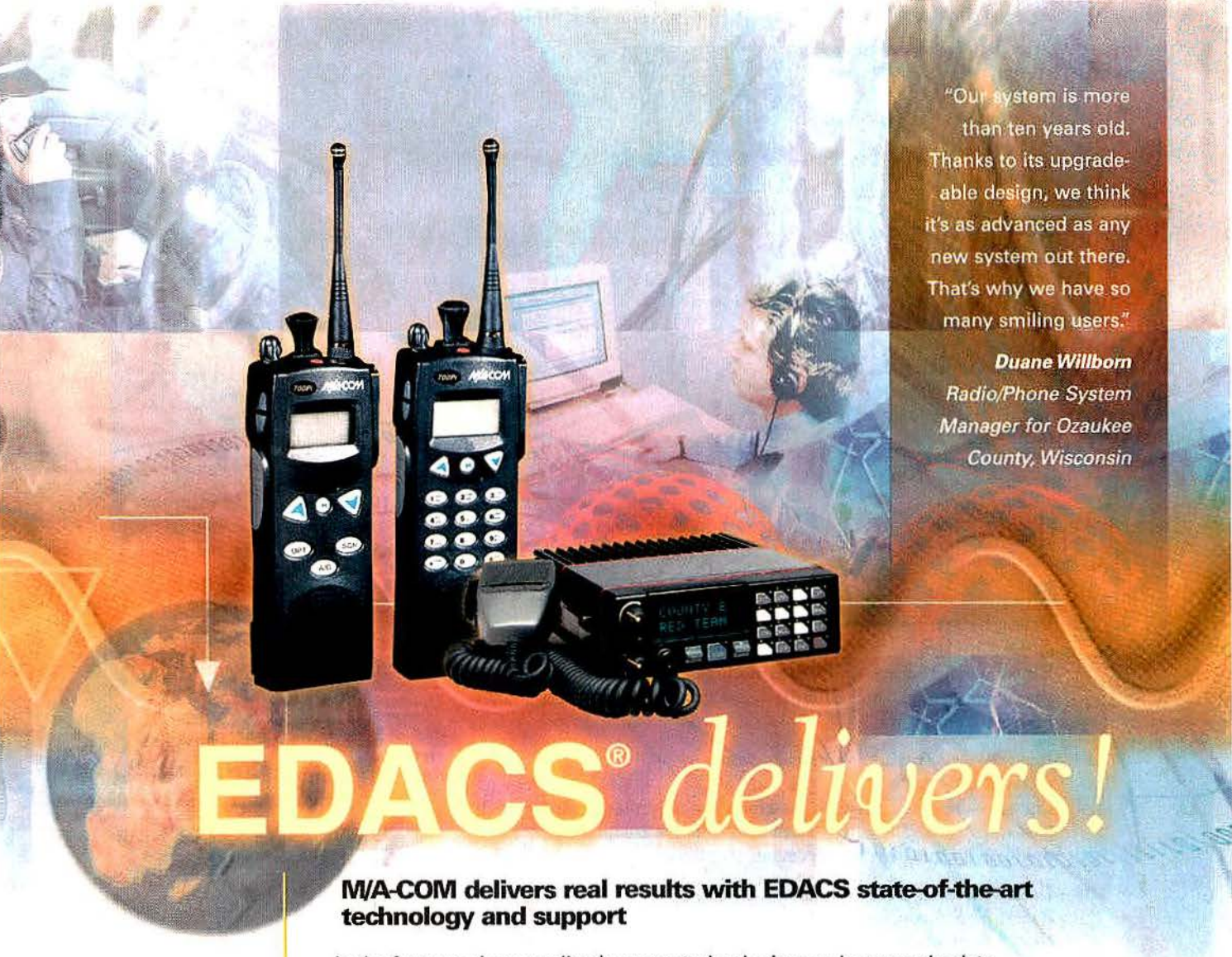
CIRCLE (1) ON FAST FACT CARD



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CIRCLE (4) ON FAST FACT CARD

On the cover: Chicago has 125 sites scattered thoughout the city, safeguarding its public safety networks from attack. If a site fails, traffic is re-routed. See page 16.

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FEBRUARY 2002
Volume 20, Issue 2

Features

ON THE WEB AT WWW.MRTMAG.COM:

Why 220MHz?
The 220MHz band may hold great promise for business and industrial users. Learn why a move toward 12.5kHz-wide FM may extend system range compared to 5kHz technologies.

Law firm, trade group hold 800MHz confabs
Meetings regarding a proposal to reallocate land mobile radio spectrum are to be held in February by a law firm and a trade association, separately.

Departments

Nextel's 800MHz interference resolution plan will affect several industry players, if it ever goes into effect. See page 30.

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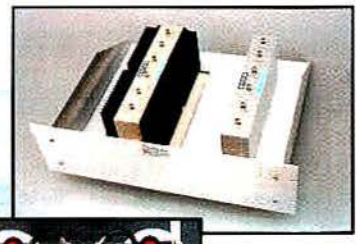

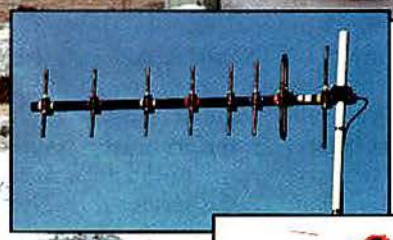

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CIRCLE (5) ON FAST FACT CARD

When push comes to ... talk

Early radio: Mute the receiver; switch the antenna; key the transmitter. Unkey the transmitter; switch the antenna; unmute the receiver. Back and forth, back and forth, and you have a conversation with the radio operator on the other end.

Big advance: Press one button, and control circuitry mutes the receiver and switches the antenna as the transmitter keys. *Push to talk.* Honestly, it was a big deal when it first came out—when, in the 1940s?

Today's radio communications users take push-to-talk for granted. But guess what? What's old is new again.

Nextel Communications promoted push-to-talk as an extra benefit to business users who subscribed to its cellular telephone service. One of the company's early descriptions called push-to-talk "executive intercom." The current description calls it "direct connect." Direct connect not only rhymes, it doesn't exclude employees and family members.

Customers didn't care why Nextel could offer push-to-talk and other cellular or PCS companies could not. Radio communications specialists understood that Nextel offered push-to-talk because the company actually had radio communications licenses, not cellular or PCS wireless telephone licenses. Until a change in FCC regulations, cellular and PCS carriers were not allowed to offer the feature.

And why should they want to? Two reasons—money and money.

The first reason, money, has to do with Nextel's success in keeping its average monthly revenue above $70 while cellular and PCS carriers draw monthly customer dollars in the $40 range. It seems as though business customers really like push-to-talk, and they use more of the costlier peak-period airtime than consumer customers.

The second reason, money, has to do with the ability to serve dispatch customers such as utilities and public safety agencies. Although Nextel's penetration into these markets has been minimal, incremental revenue is welcome at any time and is especially welcome in times of recession and slowing market growth.

Combine push-to-talk with priority access, and you have a package that is both attractive to public safety users and potentially unsatisfactory (if not dangerous) to consumers during emergencies.

Priority access moves public safety users to the top of the call queue so their calls connect before others are served. The feature helps to overcome an objection that some agencies have about relying on Nextel as a primary mobile voice communications medium. When an officer, firefighter or medical technician wants push-to-talk radio communications during an emergency, he wants it *immediately.* When he wants to use a handset to make a mobile phone call, he wants the call to be connected *right now.*

But during an emergency that affects many people and draws news coverage, Nextel, cellular and PCS networks fill with people calling public safety agencies to ask for help or to tell what they have seen. The networks fill with people calling friends and relatives to reassure them about their health and welfare. And they fill with reporters calling news editors.

Priority access would add traffic to the networks, making it somewhat less likely that calls for help would be connected as they compete for the remaining capacity. The question is whether priority access would serve public safety agency communications at the possible expense of calls for the help that the agencies provide.

Meanwhile, Nextel, Motorola and Qualcomm have inked a deal to develop push-to-talk for CDMA technology in a way that is compatible with Nextel's IDEN-technology push-to-talk. Plus, Nextel gains exclusive rights for several years to deploy CDMA push-to-talk in North America and several overseas markets. Nextel can transition to CDMA without losing its push-to-talk advantage to CDMA competitors.

Nexteland is a place where public safety agencies can pay Nextel to carry their dispatch communications. It's where Nextel bills dispatch calls by the number of units called, plus airtime. It's where Nextel's radio interference to public safety communications is overcome because, well, by golly, radio interference *by* Nextel may have contributed to a decision to buy radio service *from* Nextel.

Nexteland is a world where a possible frequency swap with public safety agencies might give Nextel radio spectrum for third-generation cellular service using—guess what?—CDMA in the 2,100MHz band with exclusive push-to-talk service.

It's a beautiful world, isn't it?

All thanks to that little thing that most carriers left alone during the wireless boom days—push-to-talk.

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Editorial Director
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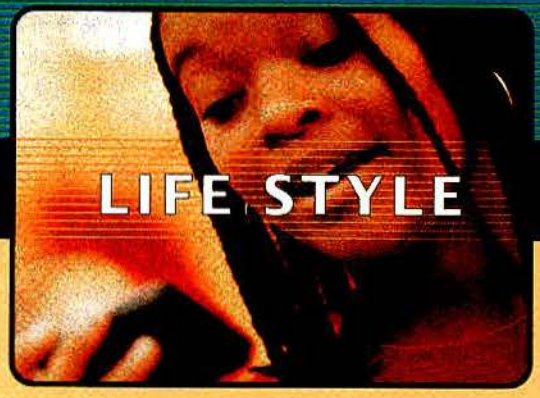

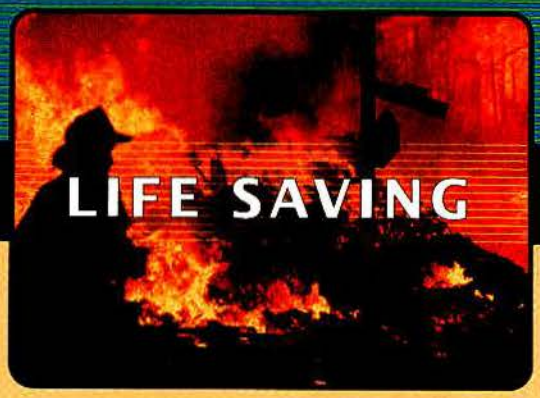

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CIRCLE (6) ON FAST FACT CARD

'Many new systems are less reliable than the systems they replaced'

As a "ham" and former EMT, I have been an *MRT* reader since its inaugural issue in the early 1980s, and have been involved with radio since the mid-70s. I would like to thank you for having the courage to write, "The times of lower frequencies and glowing tubes" (*In Sync*, August 2001) and to publish Mr. Dunford's article, "Interoperability Simplified" (*Public Safety '10-2'*, August 2001).

Both articles bring home the point that newer is not necessarily better. Around the country, there have been reports of new, extremely high-tech (not to mention extremely expensive) radio systems that perform poorly and are very complicated to operate. While higher frequencies may provide greater channelization, range is often compromised. Worse, many people in government and public safety appear pressured by manufacturers and others to buy "the latest and greatest." The average police officer, firefighter or EMT needs the ability to stay in touch with dispatch and colleagues, and most importantly, to request assistance in an emergency. Many new systems are *less* reliable than the systems they replaced, due to complexity and propagation characteristics. To these users, radios are tools to facilitate their work, in the same way they use sidearms or rescue equipment. They are not an end to themselves.

Also, simple VHF networks and mutual aid channels, such as those received easily on Mr. Dunford's "lowly scanner," can literally be lifesavers. Radios on these bands provide good range, ease of use and low cost. There are numerous instances throughout the country where the "old radios" allowed communication, especially between agencies and jurisdictions, when the 800MHz digital did not.

Thank you to you and your magazine for continuing to tell the complete story.

—Gregg Danzer
Pleasant Garden, NC

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CIRCLE (8) ON FAST FACT CARD

The faces of fatality in the tower business

Death can come at any time for any of us. Last I heard, the mortality rate for humans was 100%. However, a few precautions in our daily lives can at least postpone us reaching that final destination.

With dangerous jobs in particular, managers and workers should be especially diligent in safety. In our industry, one of the most dangerous jobs is tower construction and maintenance. Tower workers climb or are hoisted to heights of hundreds of feet.

In January, three men plummeted to their deaths when a one-inch rope hoisting them up an Alltel Communications tower broke. They plunged 100 feet when the rope snapped. The workers and a foreman were changing guylines on the tower near Forrest City, AR. The *Times-Herald* in Forrest City reported that the rope hoisting the three men up the 250-foot tower was tied to the front of a pickup truck being backed up by the foreman. (See "Three Die in Fall from Tower," **www.mrtmag.com**.)

If you know anything about OSHA guidelines, this incident should have raised a few red flags in your mind.

An "Alert" released by the National Institute for Occupational Safety and Health in July of last year listed steps that employers should take to reduce the risk of worker injuries and deaths from falls during tower construction and maintenance. One of the first points was "ensure that hoisting equipment used to lift workers is designed to prevent uncontrolled descent and is properly rated for the intended use."

Another important guideline (originally stated in OSHA's compliance directive CPL 2-1.29, which became effective Jan. 15, 1999) was that only two tower erectors at a time were to ride the line for work at heights more than 200 feet "when towers are erected with a gin pole, conditions preclude the use of a personnel platform and other conventional methods of climbing using a ladder or other approved climbing devices might create a greater hazard from fatigue or repetitive stress."

When workers have to be hoisted for work on a tower, the minimum requirements include worker training, trial lift and proof-testing procedures, and pre-lift meetings.

These are just a few of the key guidelines/directives that OSHA and NIOSH have published. In the same document, NIOSH stated that "recent NIOSH fatality investigations suggest that employers, supervisors, workers, tower owners, tower manufacturers and wireless service carriers may not recognize or appreciate the serious fall hazards associated with tower construction and maintenance."

To control safety, you must think safety in everything you do. Be in control of yourself and never put tower work schedules ahead of your personal safety—good advice from John and Mark Hill, safety columnists for *Site Management & Technology* magazine.

Nikki Chandler

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CIRCLE (10) ON FAST FACT CARD

Public dollars and sense

By Robert H. Schwaninger Jr.

Nextel Communications has composed a plan to relocate licensees in the 800MHz band. The plan would result in public safety entities obtaining additional 800MHz spectrum in a contiguous block, away from the harmful interference presently suffered by public safety entities from operation of Nextel's system. It is also reported that APCO tacitly approves the plan. (See "Dealing with a Rude Neighbor," page 30.)

Illustration by John Hayes

To those who have faithfully served APCO and its membership, I must humbly and with the greatest of respect, inquire: Are you nuts?

The above question is not intended to suggest that neither APCO nor its representatives are failing in any regard, but for a momentary lapse of perspective. With the bright, shiny prospect of additional spectrum, coupled with a possible solution for harmful interference, one might be drawn to this fix—particularly when the offer includes $500 million in relocation costs for public safety entities.

But step away from the candy counter for a moment, and let's look at this, not as radio folks, but from the perspective of the politicians, economists and boards that will have to vote on whether public dollars would be spent in support of the Nextel agenda. That portion of this equation must be considered if Nextel's plan is to be given a logical assessment.

Say I'm a city manager, and a radio guy comes to me and says, "Guess what. The FCC just ruled that we get some more 800MHz spectrum. Additionally, Nextel's put up $500 mil' to relocate us off of our old 800MHz channels. Whattaya' think? Cool, huh?"

Here's my reply:

"Charlie, we just paid to move from VHF to 800MHz about two years ago. That move cost this city a fortune, especially when we decided to upgrade the computers, consoles and every other darn thing. Now you're telling me that we gotta move again?"

"But this time Nextel's gonna pay the cost ... well, part of it."

"What do you mean, part of it?"

"Well, Nextel's paying the first $500 million into a fund to pay for relocating public safety radio systems, but that will be spread around to all of the relocating agencies, like us."

"Wait a minute, Charlie. Isn't Nextel the outfit whose cellphones have been tearing up our communications over on Dover Street and down along Broadway?"

"Yeah. Their system causes adjacent channel interference to our radios. We've been after them to fix it for a while, but so far they keep blaming our radios."

"So, let me get this straight. This city goes out and spends a couple of million on a new radio system and within two years after it's installed, Nextel is telling us that our radios are lousy? How can that be?"

"Well, sir, the answer is pretty technical, but mainly it has to do with the fact that their digital system is using channels along side of our analog system and there is a question of whether the two systems are compatible in that environment."

"Did we know about this possible problem before we bought our system?"

"Well, technically we knew about it. But we thought Nextel would build its system to avoid the problem. They didn't, so there you are."

"So now Nextel's answer is to move us to another spot in the 800MHz band, using some portion of money in a $500 million fund, and we're supposed to live happily ever after?"

"That's about right."

"Charlie, you've put me in a difficult position. First, I gotta tell the city council that the millions I got them to spend on our present system may not have been a great idea. Second, I have to tell them that Nextel is beating up our system, but we aren't doing anything to make

Schwaninger, *MRT's* regulatory consultant, is the principal in the law firm of Schwaninger & Associates, Washington, which is counsel to Small Business in Telecommunications. Schwaninger is also a fellow of the Radio Club of America. His email address is *rschwaninger@sa-laywers.net.*

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CIRCLE (11) ON FAST FACT CARD

Nextel fix it and they aren't offering us any money directly to fix the problem. Instead, we might have to move again to other frequencies and some of the cost of moving might be offset from Nextel's fund, when we don't even know how much money we're talking about and how many other agencies will be drawing from the fund."

"That's about it, but ..."

"Charlie, have you seen our tax receipt numbers? Revenue to the city is down during a recession and we don't have a lot of extra dough for retuning radios. We already had to cancel the new high school project because the budget can't take it."

"I see what you mean, sir, but there is a long-term solution."

"What is it?"

"We just move to 700MHz when the equipment becomes available."

"Charlie, with all due respect to Marconi, how am I going to sell the city council on the idea of one move, much less two? Let's try this. How about we just get Nextel to fix the problem on the present channels? Their problem. Let them fix it."

"But, sir, then we don't get the additional spectrum that is part of the deal."

"Charlie, let me give you a free lesson in government. It isn't about spectrum. Frequencies don't vote. It's about having a budget that's big enough to solve problems, improve infrastructure and support education. John Q. Public does not give a fig about ... what's it? ... adjacent channel interference. He wants better schools, less congested roads and more parks. And without money, all of the spectrum in the world doesn't mean squat."

"So, what should we do?"

"Tell Nextel to send us a fat check, get the hell off of the frequencies that are tearing up our system and let them fix their own problems."

"They say they won't do that."

"Then get me Congressman Stampferd on the phone and when I'm done talking to him, let me talk to Sam Jenkins at the *City Gazette*. Let's see who communicates best in this town." ■

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Editorial Director—Don Bishop, *dbishop@primediabusiness.com*
Editor—Roger Lesser, *rlesser@primediabusiness.com*
Managing Editor—Nikki Chandler, *nchandler@primediabusiness.com*
Associate Editor—Kari Taylor, *ktaylor@primediabusiness.com*
Editorial Intern—Adriane Roberts, *aroberts@primediabusiness.com*
Senior Art Director—Maurice Lydick, *mlydick@primediabusiness.com*
Art Director—Jani Duncan, *jduncan@primediabusiness.com*
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Contributing Editor—Donald E. Koehler, *AFDEK1@uaa.Alaska.edu*
Contributing Editor—Patrick Buller, *W7rqt@msn.com*

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CIRCLE (12) ON FAST FACT CARD

GENERAL DYNAMICS

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Show me the (radio) money!

Hint: It's not in the cars.

By David O. Dunford

At the PD last week, we completed a list of the equipment (and its associated costs) added onto, or mounted inside of, each new Ford black and white Crown Victoria to make it into a "police car."

Chief Ellen Hanson was engaged in, to put it politely, "fund allocation discussions" with other city department heads. While our small town is fortunate to have an established budget for programmed replacement of vehicles, it seems that other department heads consider a variety of apparently unrelated equipment to be part of the "base" vehicle when it comes time to purchase.

Our equipment list was a comparison tool, prepared to show that cars and equipment are really two different things. I was surprised by the list. First, the total price of all these "add on" items was just about equal to the cost of the car. Second, the price of the actual police radio was low compared to the overall equipment package. To illustrate, I've listed the items, and their actual cost, for equipment we install in each patrol car. (See sidebar on the right.)

For our department, the equipment complement 25 years ago was much different. Each car had a $150 Federal model 11 Visibar light bar, a $125 Dominator electronic siren that "burped" in the summer when the sweep oscillator capacitors got hot, and a $1,750 Motorola Micor radio. Besides the noise and lights (plus a little first aid-kit in the trunk), the radio was the main determinant for a police car. But as they say, "those days are gone."

Our contemporary car setup still relies on conventional voice dispatch, and the two-way radio is still the officer's communications link to the world. But the job of a modern officer is so much more demanding and complex that the ancillary equipment related to these additional tasks is staggering—both for the installers and for the accounting department. Fortunately, the life cycle for each "add on" item is fairly lengthy, so we don't replace everything with each vehicle change cycle.

Mobile Video System:	$4,500
Communications:	$5,950
Voice Radio	$650
Data Radio-Modem	$525
Computer	$4,625
Scanner	$150
Emergency Equipment:	$6,160
Console	$250
Audible/Control	$1,810
Visible	$1,350
Wiring/Misc	$2,750
Security:	$3,655
Cage	$425
Weapon Mounts	$280
Weapons × 2	$2,500
Transport Seat	$450
Miscellaneous:	$1,350
TOTAL	$21,615

Curiously, the radio equipment accounts for only about 3% of the total "add on" items to outfit a patrol car. Technology has continued to drive down equipment prices, and the improved design and manufacturing techniques have extended reliable life cycles for electronic equipment. We figure that about 90% of our add-on vehicular equipment "problems" are related to the original installation (or complications thereto), and the actual failure of electronic circuitry, even in the harsh automotive environment, is relatively rare. Mobile video systems, while built quite well, still require constant attention, principally because of their opto-electro-mechanical makeup.

Like me, many readers are primarily focused on public safety radio communications, and it's easy to forget about the other 97% of the cost of police vehicle equipment. We owe it to our organizations to keep an eye open to the "big picture" of fleet costs. ■

Dunford, *MRT's* public safety consultant, is technical services consultant for the Lenexa, KS, Police Department. He is a member of the Association of Public-Safety Communications Officials–International. You can email Dunford at *mrt@primediabusiness.com.*

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CIRCLE (13) ON FAST FACT CARD

Security snapshot: The Windy City

Even though Chicago centralized its public safety radio networks seven years ago, it didn't put all of its 'eggs in one basket.' Redundancy protects from attack.

By James Careless

When it comes to security, Chicago's public safety networks are protected by design.

The reason? Seven years ago, Chicago amalgamated the radio networks of its police, fire and EMS. Yet in doing so, the city didn't put all its eggs into one basket. In fact, these networks are a model of decentralization, and thus difficult for terrorists to discount.

Granted, dispatch for police, fire and EMS has been centralized at the new Chicago Emergency Communications Center. (At 1400 W. Madison Street, the 161,000-square-foot CECC can handle as many as six million calls a year.) However, it is not one-of-a-kind—a redundant 9-1-1 dispatch center exists elsewhere in Chicago.

Meanwhile, the nuts and bolts of Chicago's amalgamated radio networks are anything but centralized. The whole system is a fine example of "distributed networking," to borrow a term from the computer industry.

"We've got about 125 radio sites scattered throughout the city," said William Carter, supervisor of

Careless is a freelance telecommunications writer based in Ottawa, ON, Canada. His email address is *james@jldesign.com*.

Opposite: The city of Chicago contracts with private owners of buildings for some of its antenna placement.

The third floor of the Chicago Emergency Communications Center houses the control room for the dispatch center (located on the fourth floor). Technicians enjoy ample room for maintaining the control room.

electronic operations for Chicago's Office of Emergency Communications. "These are all cross-connected so that if one site suddenly goes down, traffic is automatically re-routed to the next-best transmitter."

To put this in a Sept. 11 context, if the Sears Tower or any other major Chicago building should collapse, the city's public safety networks would be unaffected. In contrast, the Port Authority of New York and New Jersey was seriously hurt by the World Trade Center's collapse—in large part because the WTC was its headquarters—while the New York State Police had to scramble to re-establish radio service in the area.

Actually, the Sears Tower doesn't even fit into the equation, said Carter, because "it's too high" for the city's transmission needs. "All public safety systems are designed for portable operations, so optimal height for locating radio transmitters is about 250 feet, while 150 to 200 feet up is best for receivers," he said. That's why the Sears Tower, with its rooftop at 1,450 feet above street level, doesn't qualify as a public safety site.

Public safety network snapshot

With nearly three million residents and a territory spanning some 228 square miles, Chicago is a seriously big city. That's why it takes 13,669 police officers, 4,205 firefighters and 612 paramedics to serve this region. In 2000, the Chicago Police alone handled 2,833,788 dispatches.

To do the job, "the police and EMS use UHF radios (460MHz)," said Carter, "while fire operates on VHF (154MHz). All of them operate across 27 zones: 13 police, two data network," he said. This network supports in-car terminals within the city's emergency vehicles. "Our police alone make a million inquiries over these terminals each month."

In addition, the CECC can use the data network to track the whereabouts of fire trucks and ambulances at all times. As Chicago Mayor Richard M. Daley said on Oct. 22, 2001, this tracking system "allows us to reallocate our emergency resources instantly."

Speaking of data, Chicago's EMS service has access to a total of 24 telemetry channels (eight frequencies reused across three zones). These channels are used by paramedics to send ECG and other life-sign readings directly to the hospitals that receive emergency patients.

"We've modified the paramedics' portables so that they can plug them directly to these electronic measurement devices," Carter said. "This means they can send readings back from anywhere in the field."

Intriguingly, Chicago's OEC tested the performance of these EMS systems by sending paramedics deep into the Sears Tower's lower level basement. How well did the portables send voice and data from two stories below ground? "We achieved a 95% reliable communications rate," Carter said. "It was an impressive performance."

Radio sites

As Carter mentioned, Chicago has a total of 125 radio sites. Most are on medium-sized buildings, he said. In fact, "only 18 are on tower structures owned by the city."

In general, Chicago's radio towers are three-legged, self-supporting and 250 feet tall. Thanks to consulting work by Lyncole XIT Grounding (**www.lyncole.com**) of Torrance, CA, the towers resist damage from lightning strikes.

Carter hired Lyncole a few years ago when he noticed that equipment at certain towers was suffering far more lightning damage than at other towers. These towers were older and so were poorly grounded because of weathered connections and obsolete grounding practices.

To say the least, this problem worried Carter. After all, these towers are interconnected into the CECC's 200-mile-long fiber-optic network, which is augmented by

1,000 miles of underground copper. The last thing Carter wanted was to turn the CECC's equipment into an expensive lightning resistor. So the decision was made to call in Lyncole, which specializes in detecting and fixing grounding faults.

Finally, there are the fiber optics themselves. "All of our primary transmitter sites are connected by fiber optic cables," Carter said. "Fiber was expensive to deploy, but it gives us a measure of reliability that nothing else can match." Add to this the CECC's dynamic switches, which can shift feeds from one transmitter to another as required, and the result is one solid radio system.

The 161,000 square foot Chicago Emergency Communications Center is located at 1400 W. Madison.

One vulnerability exists for now

No system is perfect, of course. In the case of Chicago's public safety networks, the problem is compatibility. Despite amalgamation, the city's police, fire and EMS cannot talk to each other by radio. Instead, everything has to be coordinated through the CECC.

This is why—as reported in the November 2001 issue ("Chicago Blazes Affordable Path to Radio Interoperability")—the city is developing a radio interoperability pilot project. Spearheaded by Rich Nowakowski, Chicago's project manager for radio interoperability, the Chicago test will use six TRP-1000 transportable interconnect systems to link public safety crews in the field.

Designed to serve as a telephone-style switch, the JPS Communications-built TRP-1000 allows 10 radios and two phone lines to be plugged in, and it interconnects them all. Chicago has already built one switch into a converted 1992 Ford ambulance and will be testing it in the field soon.

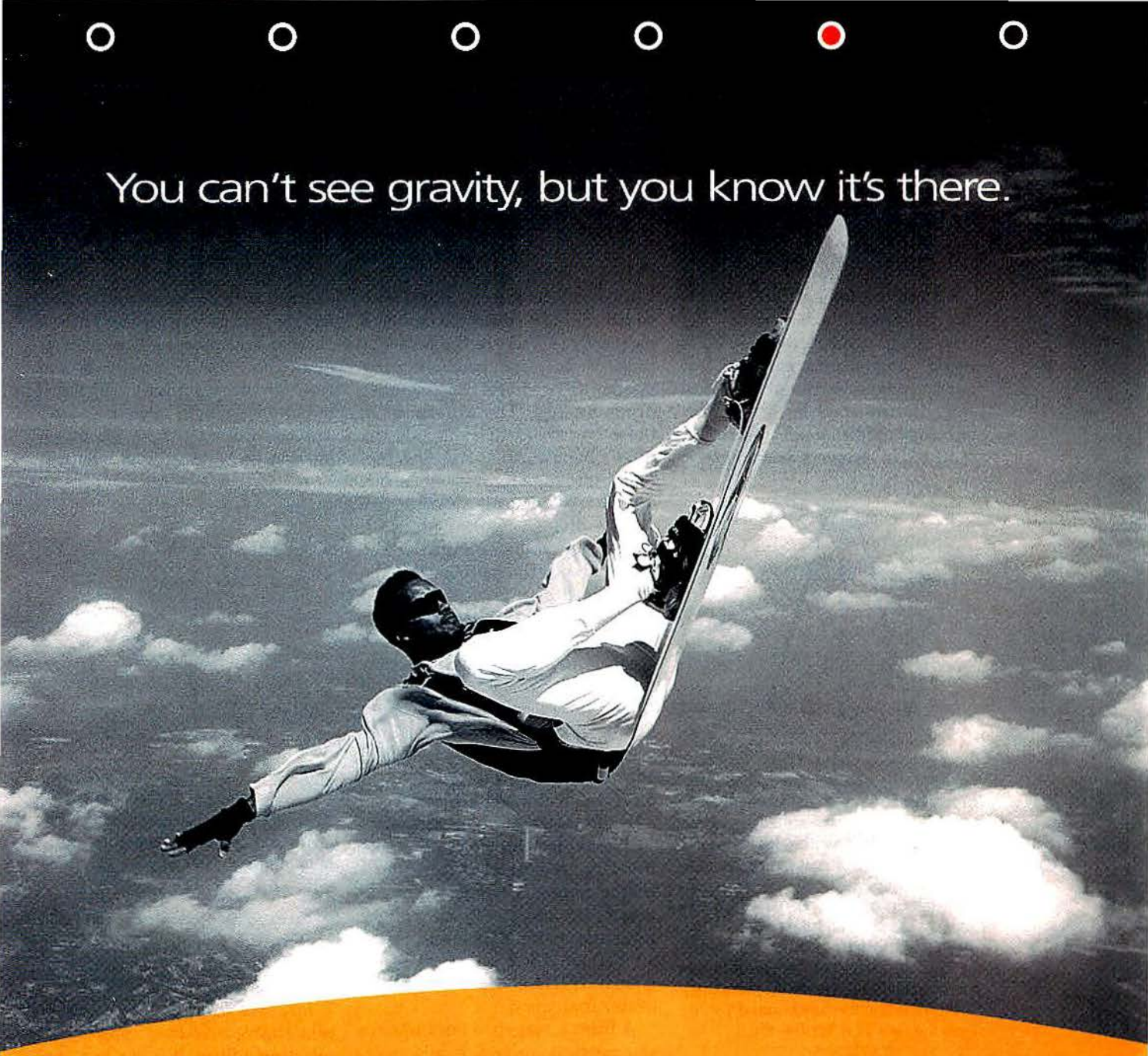
Verdict? Chicago's done it right. Chicago's public safety networks are well-positioned to resist attack. There are no two ways about it.

"We did the right thing in amalgamating our networks in this way," said Carter, who designed the system as an economical alternative to expensive upgrades to Chicago's separate police, fire and EMS networks in 1990.

Even though the new design was not focused on decentralization as a security measure, decentralization is proving to be the best way to protect public safety networks against the kind of failure that can be caused by a terrorist attack. ■

Some of Chicago's 125 radio sites exist on city-owned smoke stacks.

You can't see gravity, but you know it's there.



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CIRCLE (14) ON FAST FACT CARD

Getting back to basics: Filter terminology

By Harold Kinley

Filters are indispensable in radio communications systems. Receivers and transmitters use them in RF stages, intermediate frequency stages and audio frequency stages. Much of the basic filter terminology applies to all types of filters used in receivers, transmitters, multicouplers, combiners and antenna systems.

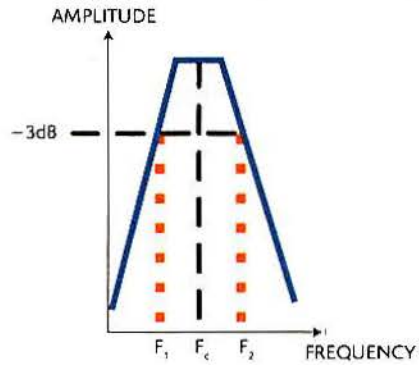

Figure 1: The bandwidth of this passband filter is equal to the difference between F_2 and F_1, the frequencies where the response is down by 3dB from the maximum value. This is called the half-power point or the point where the voltage has dropped to 0.707 times the value at the peak of the response curve. The Q of this filter can be determined by dividing the center frequency (F_c) by the bandwidth. If the center frequency is 150MHz and the bandwidth is 1MHz, then the filter Q is 150/1 = 150.

Bandpass

Bandpass filters pass a given band of frequencies and reject frequencies outside the passband.

When selecting a bandpass filter, first determine how much rejection or attenuation must be provided by the filter at frequencies outside of its *bandwidth*. The bandwidth extends to frequencies above and below the filter's *center frequency*.

Frequencies above and below the center frequency, at which the filter response falls to a level 3dB below the center frequency, define the limits of the bandwidth. Figure 1 illustrates how to calculate bandwidth. Simply subtract the lower frequency (F_1) where the response drops by 3dB from the higher frequency (F_2) where the response drops by 3dB. The difference in these two frequencies equals the filter's bandwidth.

Another important filter characteristic is "Q." The filter's center frequency divided by its bandwidth defines its Q. (See Figure 1.) The higher the Q, the more narrow the bandwidth at a given center frequency. In land mobile radio work, cavity resonators achieve high Q. Crystal filters offer high Q, but they have higher insertion loss. And crystal filters can't be subjected to high transmitter power.

Selectivity makes a big difference in selecting the proper filter for a particular application. Usually, the selectivity is described as "so many decibels down" at some frequency removed from the filter's center or pass frequency. For example, the selectivity of a cavity resonator at 155MHz might be described as "15dB down" at a frequency 1MHz above or below the center frequency.

A filter's response isn't always symmetrical. In fact, it seldom is. Therefore, the actual response might be "12dB down at 1MHz above the center frequency" and "15dB down at 1MHz below the center frequency."

Shape factor expresses filter selectivity in another way, as a ratio of the filter's response at 60dB of attenuation and 6dB of attenuation. Generally the shape factor is defined as shown in Figure 2. The lower the shape factor, the steeper the skirts of the filter's response curve. For example, a shape factor of unity would indicate that the response curve of a filter has a rectangular or square shape—not available in the real world.

Figure 3 shows additional filter characteristics of *ripple* and *return*. Ripple occurs within the filter's passband. Expressed in decibels, it quantifies the difference in the level of the maximum (crest) to minimum (trough) response. Don't confuse "filter return" with transmission line "return loss." Return

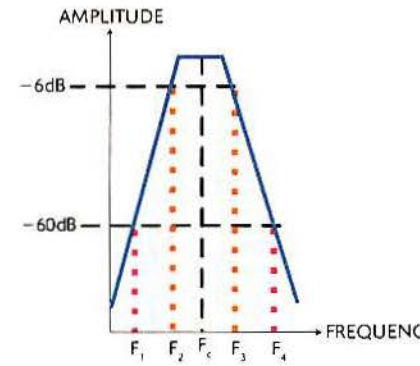

Figure 2: The shape factor of this bandpass filter can be determined by determining the frequencies of the 6dB points and the 60dB points. The shape factor is then equal to $(F_4 - F_1)/(F_3 - F_2)$

is an unexpected and unwanted peak in the response curve in the frequencies outside of the passband, known as the *stopband*.

Insertion loss is another important characteristic to consider in selecting a filter. It is the loss presented to the signal as it travels in the desired signal path. Generally, it is desirable to keep insertion loss to a minimum. In the real world, however, a certain amount of insertion loss must be accepted to achieve the desired or required degree of selectivity. Fortunately, insertion loss doesn't always harm

Contributing editor Kinley, *MRT's* technical consultant and a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual, with Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301. His email address is *halkinley@charter.net*.

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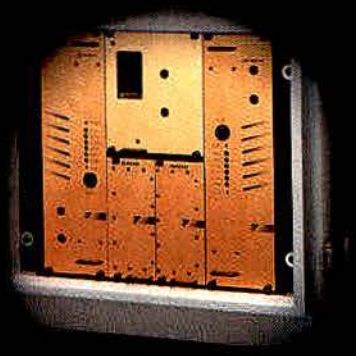

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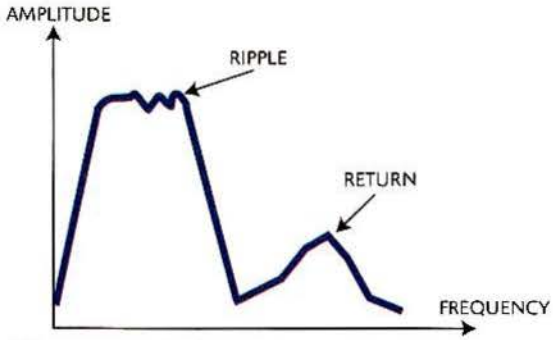


Figure 3: Ripple in the passband or return in the stopband can be detrimental to circuit operation.

the system performance. In many cases, several decibels of insertion loss might be tolerated before system performance begins to degrade. An example is a transmitter site with high ambient noise—more the rule than the exception these days.

One important thing to remember about insertion loss is that the *filter's power input rating* must be based on its insertion loss. Insertion loss causes the filter to dissipate power. The higher the insertion loss, the more power dissipates within the filter.

For example, when 100W is applied to a filter with 3dB insertion loss at the operating frequency, the filter must be rated to dissipate 50W of power. Power dissipates as heat, and the filter must be able to withstand the dissipation.

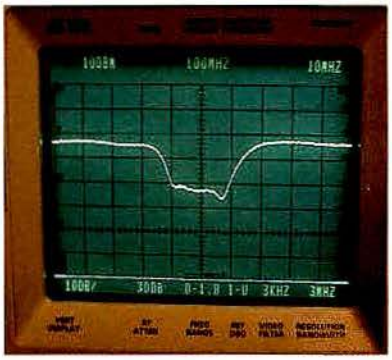
Inherent high insertion loss is cited as a reason not to use crystal filters. But where crystal filters are needed, it is rare that the insertion loss would cause serious degradation to the receiver system performance. Crystal filters normally are considered in the first place when site noise is usually high—so high that the insertion loss is of little consequence.

Band-reject

Band-reject filters reject a frequency or a band of frequencies while passing all others. The response of a simple band-reject filter looks like an inverted passband filter response. Photo 1 shows a CRT display of the response of a band-reject filter built into a broadband preamplifier. This band-reject filter attenuates signals from stations in the FM broadcast band.

Bandpass/band-reject

Bandpass/band-reject filters are sometimes simply called *pass-reject* filters. You may see the name abbreviated as "BpBr" (or something similar). The pass-reject filter is commonly used in duplexer configurations. It can be designed to reject one frequency and pass another frequency with little separation between the two. Repeaters often have closely spaced transmitter and receiver frequencies and a need for a pass-reject duplexer.



CRT display of the response of a band-reject filter built into a broadband preamplifier.

In today's crowded spectrum, few of us can get by without having to purchase and install filters of one type or another. On the bright side, most applications engineers at companies that manufacture and sell such filters are quite knowledgeable and helpful. Discuss your needs with them, and they will usually come up with a solution for your interference problem. The more you know about filters, the better you can communicate with the applications engineer.

Until next time—*stay tuned!* ■

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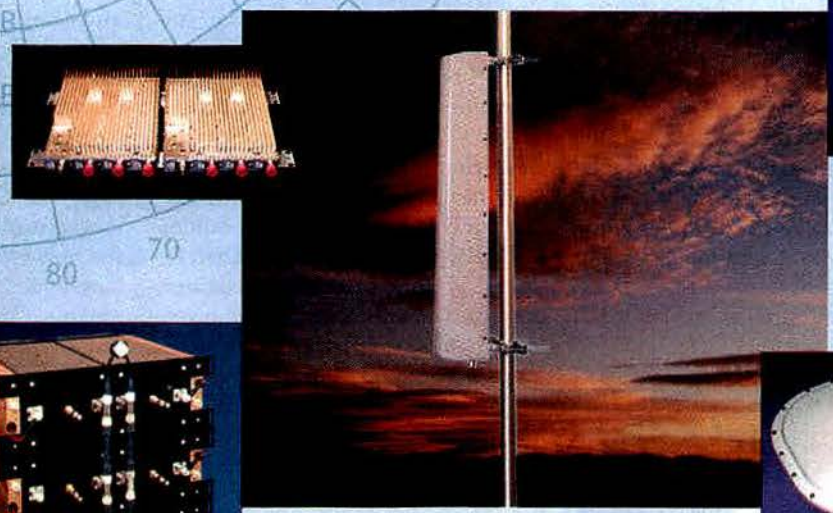

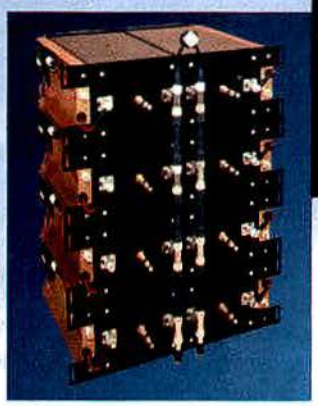

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Boxing communications

College campuses or road sides aren't the only places wireless call boxes are used. These boxes can also improve customer service, productivity and risk management.

By Adriane Roberts

Wireless call boxes are being put to the test. Businesses are looking for effective communications with readily available responses. Wireless call boxes can enhance customer service, productivity, sales and risk management worldwide.

Call boxes can supply instant, reliable two-way communications and an increased level of safety, security and convenience. With the latest technological developments, these call boxes combine basic and critical operating features.

"We have found in our research

that wireless call boxes could be used in a number of emergency and non-emergency applications," said Jack Pelzman, marketing communications manager for Ritron, Carmel, IN.

These applications include golf courses for emergency response, shopping centers to provide a safe environment for shoppers and hotels and motels for wireless communications at the pool or other common areas. A help box can also be used, which can eliminate the need for employees to be stationed at gates, parking structures and lots, delivery and receiving docks, will-call desks, lobbies or other unattended areas.

Call boxes can operate 24 hours, providing an instant, direct link to on-duty staff. This allows two-way voice communications between staff and the caller. The call box can automatically identify and locate callers.

Scott Adams of Adams Distributing, Wixom, MI, a Ritron dealer, has started seeing increased interest in these call boxes after sending several mass mailings about security issues after Sept. 11. For example, he has installed call boxes in two buildings for a university. The Ritron RQX-454 call boxes were mounted indoor, on the wall.

"They wanted some sort of method for the occupants of the building to be able to get help when they needed it, and they looked at the budget issue of having to wire hardwire phones mounted in the hallways. Their alternative was to go with wireless because it saved them a ton of money and it didn't require any infrastructure, number one, and number two, it didn't tie anyone to a fixed desk location; for instance late in the evening or after hours," Adams said.

East Tennessee Children's Hospital, Knoxville, TN, had 13 of Ritron's RQX-454-XT (trunking versions) installed in their parking garage in December. The hospital is using the DTMF ANI feature of the call box with Motorola HT1250 portables that will decode the DTMF and display the corresponding numbers. Mike Russell of Metro Communications, Knoxville, TN, the dealer who installed them, said, "They built a new parking garage for their employees. It was a couple of blocks away from the hospital, and they wanted them to get in touch with security. So we put the call boxes in for them and gave them the coverage that they were looking for."

For Buddy Williams, head of security at East Tennesse Hospital, it was a learning experience with the new technology. He wanted his employees to have access to him and his officers if they had trouble, but he said that it took two months to get the call boxes working the way he wanted.

Many call boxes require a source of commercial power to operate the radio and lighting. However, this requirement restricts the locations of call boxes to those areas having electric power available. You can trench power cables to a call box location, but that can be expensive. The places where you need a call box could be precisely where there's no power. Call boxes that require commercial power can't operate for long if the power is interrupted. To meet some minimum specs about power failure, a large box of batteries must hang near the call box, and there could be an enormous cost of replacing those batteries every year or so. Power storage cells have an expected life of three years. Replacement of the battery takes minutes and costs about $60 per call box. Call boxes are available with high-capacity solar chargers that keep the internal batteries fully charged.

Radio range varies depending on radio power, which frequency is used

Roberts is editorial intern from the University of Kansas. Photos courtesy of Ritron, Carmel, IN.

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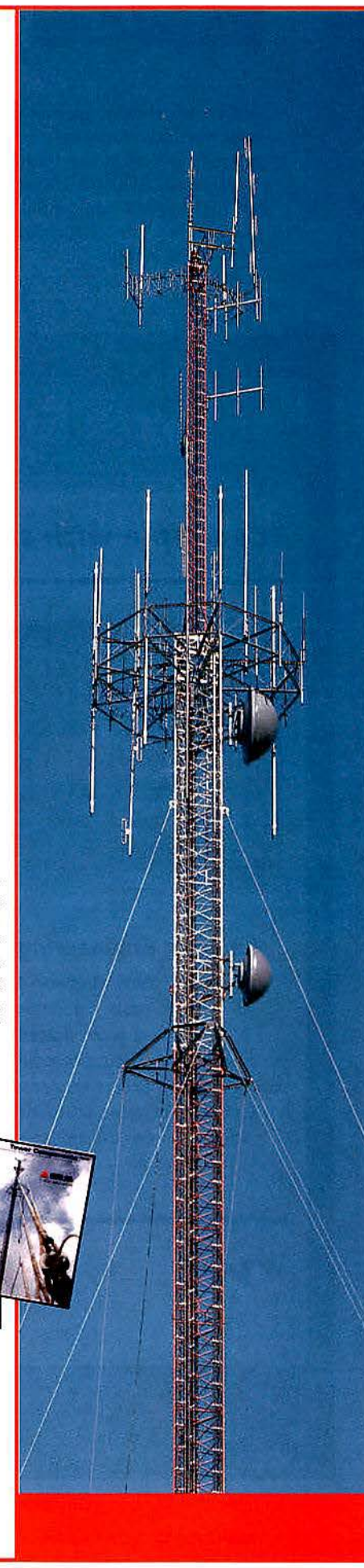

CIRCLE (18) ON FAST FACT CARD

and your particular application's terrain and environment. A typical range at 4W of power with an antenna mounted atop a 16-foot pole is six to 10 miles. An available yagi antenna can extend signaling range as much as 20 miles.

All voice messages are recorded directly into the call box before or during installation. Voice messages can be re-recorded (to accommodate relocation or changing circumstances) at any time without a technician.

A feature that was added to East Tennessee Children's Hospital's call box was a relay and light that comes on when the box is activated. It is a flashing blue strobe light that when activated, can aid responders in locating the alert site, and attract attention to the area.

"When the button is pushed on the call box, we did some modifications for them so that a beacon or strobe light would come on and would remain on until an officer responded," Russell said. "And so what it's done for him (Buddy Williams) is to provide peace of mind for his employees."

A need to speed players through the ninth hole led to call boxes being installed on golf courses. It is common for courses to be arranged so that the ninth and eighteenth holes are near the clubhouse. Unfortunately, players coming off the ninth hole often drop in to the clubhouse for food or drinks before continuing to play the final nine. This results in delays and restaurant workers struggling to keep up with the crowd of golfers. "We get them (call boxes) out on the fifth or the seventeenth hole where they can call in their meal order at the clubhouse or get help if there's a medical emergency," Adams said. This reduces the number of people waiting at the clubhouse and allows golfers to play more rounds.

Call boxes on golf courses helps clubhouse workers keep up with crowds.

Retailers of all sorts are enhancing responsiveness with the help of wireless call boxes. With a competitive marketplace that requires the highest level of responsiveness to customers, how quickly you respond to your customers' needs links directly with satisfaction and loyalty.

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San Diego–based Indyme, which designs, builds and installs communications equipment, systems and software, has discovered many benefits from using wireless call boxes for shoppers. To convert shoppers to buyers, prompt customer service is needed. With these call boxes, customer wait time is reduced. It can create a more pleasing shopping experience for customers, including faster checkout, carry out and price checks.

The call boxes allow the shopping center to measure its service performance and trend, and they identify where more help is needed for the business. It allows the business to evaluate and compare its store activity chain-wide. Obtaining assistance when and where it is needed increases sales, creates repeat customers and even helps avoid safety hazards.

With the touch of a button, shoppers can easily call for assistance at various locations throughout a store. Once shoppers press the button, an automatic message is sent to the output device until store employees respond to the customer's request. This shopper call box requires little programming and maintenance. It is low-profile with a single-button membrane switch, easily activated and easily reset. It operates with other call box styles. The wireless and portable call box uses a radio signal to communicate with the control unit. The box is compact and mounts directly to locked cabinets, fitting rooms and paint cages.

Indyme's front-counter call boxes allow store employees to request assistance from multiple store departments, such as security or management. Once activated, a message immediately directs assistance to the requesting location. In addition, response information can be tracked through the reporting function. This unit eliminates lost staffing hours, which reduces wait time for employees and customers. The front-counter call box instantly alerts officials to a potential problem.

For fitting room assistance, Indyme created call boxes mounted inside the dressing room areas. These provide shoppers with a means of requesting immediate assistance. When a customer needs assistance with a different size or color, they can call for help with a push of a button. The customer's request will continue to page an associate until the customer is helped and the call box is reset. Fitting room call boxes can improve customer service and increase employee-customer interaction.

With this new advancement in wireless technology, call boxes have addressed real safety and convenience issues for a wide range of applications. ■

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SS-10	7	10	1⅛ x 6 x 9	3.2
SS-12	10	12	1⅜ x 6 x 9	3.4
SS-18	15	18	1⅜ x 6 x 9	3.6
SS-25	20	25	2⅞ x 7 x 9⅜	4.2
SS-30	25	30	3¾ x 7 x 9⅜	5.0

MODEL SS-25M

DESKTOP SWITCHING POWER SUPPLIES WITH VOLT AND AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (Inches)	Wt.(lbs.)
SS-25M*	20	25	2⅞ x 7 x 9⅜	4.2
SS-30M*	25	30	3¾ x 7 x 9⅜	5.0

MODEL SRM-30

RACKMOUNT SWITCHING POWER SUPPLIES

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-10	7	10	3½ x 19 x 9⅜	4.3
SRM-12	10	12	3½ x 19 x 9⅜	4.7
SRM-18	15	18	3½ x 19 x 9⅜	5.0
SRM-25	20	25	3½ x 19 x 9⅜	6.5
SRM-30	25	30	3½ x 19 x 9⅜	7.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M	20	25	3½ x 19 x 9⅜	6.5
SRM-30M	25	30	3½ x 19 x 9⅜	7.0

MODEL SRM-30M-2

2 ea SWITCHING POWER SUPPLIES ON ONE RACK PANEL

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30-2	25	30	3½ x 19 x 9⅜	11.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30M-2	25	30	3½ x 19 x 9⅜	11.0

MODEL SS-12SM/GTX

MODEL SS-10EFJ-98

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GE MARC SERIES
GE MONOGRAM SERIES & MAXON SM-4000 SERIES
ICOM IC-F11020 & IC-F2020
KENWOOD TK760, 762, 840, 860, 940, 941
KENWOOD TK760H, 762H
MOTOROLA LOW POWER SM50, SM120, & GTX
MOTOROLA HIGH POWER SM50, SM120, & GTX
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
UNIDEN SMH1525, SMU4525
VERTEX — FTL-1011, FT-1011, FT-2011, FT-7011

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SS-18GX
SS-12EFJ
SS-18EFJ
SS-10-EFJ-98, SS-12-EFJ-98, SS-18-EFJ-98
SS-12MC
SS-10MG, SS-12MG
SS-101F, SS-121F
SS-10TK
SS-12TK OR SS-18TK
SS-10SM/GTX
SS-10SM/GTX, SS-12SM/GTX, SS-18SM/GTX
SS-10RA
SS-12RA
SS-18RA
SS-10SMU, SS-12SMU, SS-18SMU
SS-10V, SS-12V, SS-18V

CIRCLE (23) ON FAST FACT CARD

*ICS – Intermittent Communication Service

Dealing with a rude neighbor

Nextel Communications' plan to help solve interference with public safety proposes a reshuffling of spectrum usage and licenses. Why should the industry accept this deal?

By Robert H. Schwaninger Jr.

In what must be viewed as hubris squared, Nextel Communications, Reston, VA, has proposed a reshuffling of spectrum usage and licensing within the 700MHz, 800MHz, 900MHz and 2,100MHz bands. Claiming that it is having problems meeting its obligation to protect public safety's use of the 800MHz band, Nextel proposes that the problem be solved by relocating thousands of licensees and hundreds of thousands of users. In sum, the noisy neighbor, Nextel, is suggesting that instead of its turning down the stereo, all the other neighbors be made to move away.

As has been well-reported elsewhere, and now admitted by Nextel, operation of Nextel's 800MHz IDEN system creates harmful electrical interference to analog 800MHz systems. Although Nextel's spurious emissions have cut up local operators' systems for years, Nextel has eschewed its responsibility to correct those problems. However, Nextel believes that it may have an obligation to solve the same problem if the victim is a public safety entity.

In the white paper submitted to the FCC, Nextel proposes to "trade" its spectrum holdings in the 700MHz, 800MHz and 900MHz bands for 6MHz of contiguous spectrum in the 800MHz band and 10MHz of spectrum in the 2,100MHz band. Meanwhile, all public safety use would be relocated to a 10MHz-wide contiguous block of frequencies in the 800MHz band, thereby removing public safety radio communications from harm's (Nextel's) way.

Non-public safety operators on the 800MHz band would be given an opportunity to relocate either to the 700MHz or to the 900MHz band, or to remain on their 800MHz channels with secondary status. Although Nextel has offered to contribute $500 million toward relocating public safety entities, Nextel does not propose to finance the relocation of all other affected 800MHz licensees.

People on the block

This article is being written before all groups have had a chance to be heard. Thus far, the industry players are digesting this paper and trying to decide how badly the adoption of the plan would gore their respective oxen. However, if you apply a little logic, the proposed victims begin to appear. They include the following, in no particular order:

▶ *Industrial operators* – The most obvious group is industrial operators at 800MHz, who will either have to finance a relocation to other spectrum, or accept secondary status. Either alternative is repugnant.

▶ *Commercial operators* – Local commercial providers in the

Schwaninger, *MRT's* regulatory consultant, is the principal in the law firm of Schwaninger & Associates, Washington, which is counsel to Small Business in Telecommunications. Schwaninger is also a fellow of the Radio Club of America. His email address is *rschwaninger@sa-laywers.net.*

800MHz and 900MHz bands will be shafted. The 800MHz providers are in the same boat as the industrial users, and the 900MHz providers would receive unwanted competition from relocated entities who would not be paying for their use of the spectrum. So, at the same time that 900MHz SMR operators are now paying interest and principle for spectrum purchased in the earlier auction, relocated users would get, in essence, free spectrum.

▶ *Guardband managers* – If entities could relocate to the 700MHz band without paying lease fees, then the demand for guardband frequencies would be diluted. Certainly, business plans would be placed on hold by potential users. This kind of delay would be problematic for entities such as Access Spectrum, which is paying interest on debt amassed to pay for spectrum.

▶ *Broadcasters* – Occupation of the 2,100MHz band coveted by Nextel would require relocating remote broadcast pick-up facilities. The broadcasters would need to find other channels for electronic news gathering and program uplinks using their mobile satellite uplink vehicles.

▶ *Cellular* – Nextel's plan suggests that cellular operators should be made to pay a portion of the cost of relocating public safety entities. Yet, cellular operators didn't ask to be made a part of Nextel's "solution," and it has not been clearly shown that cellular operations are indeed part of the problem.

▶ *Manufacturers* – Nextel's plan recommends new manufacturing guidelines for the production of new 800MHz public safety equipment to make it more resistant to harmful interference. The cost of retooling and trying to get public safety entities to pay the higher cost of that equipment is also quite troubling.

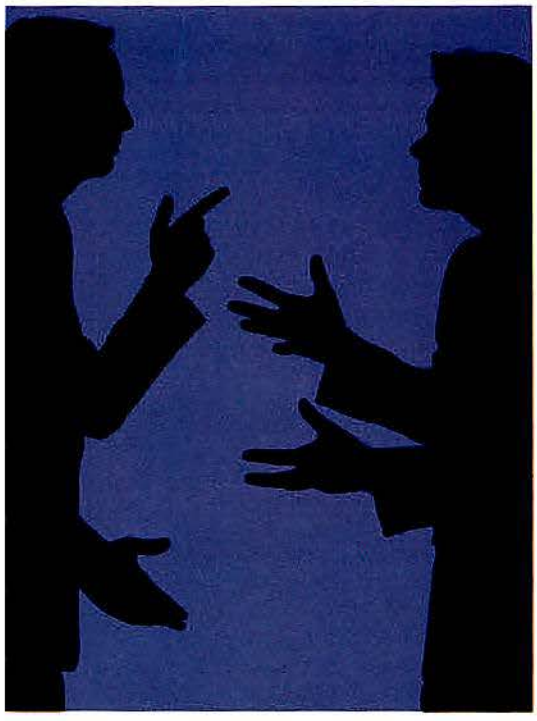
▶ *PCS* – Although PCS operators have competed well against Nextel in the market, the game board would change radically if Nextel were to obtain the 10MHz of frequencies in the 2,100MHz band for $500 million in relocation costs paid to public safety entities. That deal is equivalent to a 90% discount compared to amounts paid by large carriers in other auctions.

▶ *Relocated 800MHz systems* – Perhaps the biggest victims are the people who agreed to be relocated by Nextel from the upper 800MHz channels to other 800MHz channels. Although the channels they accepted were supposed to represent "comparable spectrum," Nextel's plan, if adopted, would mean that relocated incumbents would receive bad goods, which would require replacement.

▶ *Public safety* – Although Nextel's plan states that public safety users would wind up with more spectrum at 800MHz and would be relieved of interference problems, one has to wonder

A summary of Nextel's plan

1. Reallocate the 800MHz General Category and interleaved SMR, B/ILT and public safety channels, 800MHz channels 1–400 (806MHz/816MHz–851MHz/861MHz), to create a 20MHz-wide contiguous, primary public safety spectrum block.
2. Reallocate the 6MHz of public safety NPSPAC channels (821MHz/824MHz–866/869MHz and the adjacent 10MHz of upper 200 SMR channels (816MHz/821MHz–861MHz/866MHz) for advanced technology commercial wireless systems using "interference-limited" multiple low-site, low-power systems architecture. The FCC should license the additional 6MHz to Nextel in partial exchange for the spectrum it will vacate and swap to help implement 800MHz realignment; Nextel is already the dominant incumbent licensee on the adjacent 10MHz.
3. Reallocate 10MHz of contiguous spectrum (2,020MHz/2,025MHz–2,170MHz/2,175MHz) from MSS for exclusive terrestrial advanced commercial mobile communications services. This block is not currently being used by any MSS licensee, but includes non-MSS Broadcast Auxiliary Service incumbents that must be relocated to enable advanced mobile communications services to use this band. The FCC should license this 10MHz to Nextel as part of this proceeding in an even exchange for certain licenses totaling 10MHz of spectrum in the 700MHz, 800MHz and 900MHz bands to make the 800MHz band realignment possible.
4. Redesignate 4MHz of the 5MHz of SMR spectrum in the 900MHz band (896MHz/901MHz–934MHz/940MHz), currently licensed to Nextel, for traditional (noise-limited) co-primary B/ILT and high-site SMR use.
5. Redesignate the 50 business and 50 I/LT channels between 809.75MHz/816MHz–854.75MHz/861MHz from primary B/ILT to primary public safety use as part of the channels 1–400 public safety block. Incumbent B/ILT licensees would be permitted to remain on these channels on a secondary, non-interference basis or voluntarily relocate as described below.
6. Redesignate the 4MHz of 700MHz guardband spectrum (762MHz/764MHz–792MHz/794MHz) from guardband manager to co-primary B/ILT and high-site, analog SMR use, and modify the current service rules that apply to this spectrum to achieve this objective.
7. Expedite the current schedule for mandatory retuning of all Broadcast Auxiliary Service incumbents at 2,020MHz–2,025MHz, and to the extent necessary, terrestrial Fixed Point-to-Point Microwave systems at 2,170MHz–2,175MHz.
8. Require mandatory retuning of all advanced technology (interference-limited) CMRS SMR systems from the new 800MHz public safety block at 800MHz.
9. Require mandatory retuning of all public safety licensees in the NPSPAC channels, 821MHz/824MHz–866MHz/869MHz, to the new 806MHz public safety channels through the assistance of a special public safety frequency coordinator, as detailed below. This mandatory retuning of public safety systems would be funded in large part by Nextel, any other advanced technology SMR licensee, and the cellular licensees.
10. Permit voluntary retuning of B/ILT incumbent and noise-limited SMR incumbents to the new 900MHz B/ILT band and traditional SMR spectrum, or to the 700MHz former guardband channels, with the assistance of frequency coordinators on a first-come, first-served basis.



whether the public safety entities need more spectrum or more money. During the past 20 years, public safety entities have had difficulty migrating from the VHF bands because of the cost, not a lack of opportunity. And the 700MHz band allocation was intended to solve any spectrum shortages. If Nextel is proposing a "safe harbor" at 800MHz for public safety, what does that do to 700MHz plans? If anything, Nextel's plan creates greater confusion for public safety's long-term interoperability issues.

The whys

One must then ask why Nextel has offered this plan, and why anyone would support it. The white paper states that the plan would provide protection against harmful interference to 800MHz public safety operations, would provide blocks of spectrum reserved for incompatible digital vs. analog use, and would rationalize the allocation of affected spectrum.

One might be tempted to consider the plan based on these claims alone, but I am a bit more cynical. Or, stated another way, reasonable persons might conclude that Nextel is not merely usurping the FCC's job by proposing a radically different spectrum management plan. Nextel might be trying to make a buck.

If adopted, the Nextel plan would provide the company with an extremely valuable piece of spectrum at 2,100MHz. Nextel would be accepting a nationwide, exclusive, 10MHz band of spectrum up in the PCS range, to which present PCS equipment might be tuned. Concurrently, Nextel accepts a 6MHz band

of spectrum to which cellular radio systems might be tuned. Finally, Nextel has an exit strategy.

Having been saddled with billions of dollars of debt from borrowings made over many years, and with no date in sight for profitability, Nextel would be able to trade its patchwork quilt of channels for blocks of contiguous spectrum that might be sold. Following adoption of its plan, Nextel would finally be in position to be acquired by other large carriers—with one buying the 800MHz block to augment cellular operations, and another buying the 2,100MHz band frequencies to augment PCS operations.

Absent such a sale, the acquisition of 10MHz of spectrum in the 2,100MHz band for, essentially, $500 million, would allow the financial analysts to revalue Nextel's spectrum holdings and adjust its book value to a much higher level. Its stock prices rise based on the increased book value and Nextel's biggest investors, Craig McCaw and cronies, get a whole lot richer. In fact, the windfall might allow Nextel to obtain enough dough to buy off Motorola and free it from its sole supplier problem, allowing it to switch to CDMA technology.

The why nots

If one simply considers the underlying premise of Nextel's plan, the "why not" becomes obvious. Nextel's system causes interference. Nextel should solve the interference problem without compelling the assistance of thousands of licensees, businesses, customers and operators.

If Nextel wants to effect someone's relocation to other frequencies, it is free to relocate its own system to either the 700MHz or the 900MHz band to avoid the problem in the future. As it claims, it has plenty of spectra in these bands to trade, so it should be made to use its own solution there. The point is, Nextel's condition is of its own making, and its problems should be of its own solving. The entire industry should not have to pony up, move out, shift over and suck up Nextel's self-serving plan.

The $500 million offered as a down payment on the cost of relocating 800MHz public safety users is likely to be insufficient to cover the cost of operators' relocation even in a single major market. It's one of those numbers that sounds like a lot, but you can run through it overnight trying to pay for seamless relocation of critical public safety systems.

As for tentative support given by APCO, one need only consider the agenda of the individuals running the organization. Although I am a fan of APCO, too often the managers of the organization assess their success simply in megahertz. Following the tremendous victory obtained by the organization regarding the future use of the 700MHz band, any endorsement of this plan seems ill-focused.

Though adoption of the plan may increase the amount of available public safety spectrum, the plan does not deal with the primary obstacle for public safety entities—money. The plan increases costs to public safety entities by forcing them to pay relocation expenses and does not provide assurances that Nextel will do anything more than seed the relocation fund with $500 million. Therefore, APCO would inadvertently stick its constituents with the check for the balance.

Remember, Nextel's 800MHz channels were not, by and large, purchased at auction. Nextel obtained much of its spectrum the old-fashioned way, one $35 application at a time, listing every available 800MHz frequency that the FCC's rules could spew forth. Nextel's plan suggests that the bulk of its spectrum holdings were obtained via auction. This is nonsense.

Nextel abused the FCC's processes to grab, snatch, wrestle and slip away with every wavelength it could. Then it leveraged that activity into the cheapest prices paid for slivers of white space around its contours. The EA licenses it bought weren't purchased to obtain more spectrum, but rather to create a veneer of respectability laid over a history of application abuse.

Now, Nextel wants to launder its frequencies one more time, and its newest proposed process will slop dirty water over thousands of licensees and business plans. Reasonable people would suggest that Nextel should clean up its own mess without industry or regulatory assistance. Nextel should not create in APCO a co-conspirator that, in attempting to serve its members, might make a deal with Nextel that does not solve the problem of the noisy neighbor, but instead directs the blast at the greater public interest. ■

Nextel abused the FCC's processes to grab, snatch, wrestle and slip away with every wavelength it could.

Technical techniques: A primer for transmission lines

Part I—An understanding of transmission lines and tips on using them as transformers and filters can help techs properly configure feedlines and even solve some problems.

By Patrick E. Buller

Transmission lines carry RF from point to point within radio equipment, between pieces of equipment and from equipment to antennas. They also can be configured as filters and impedance transformers. In simple terms, a transmission line connects the source of energy to the load.

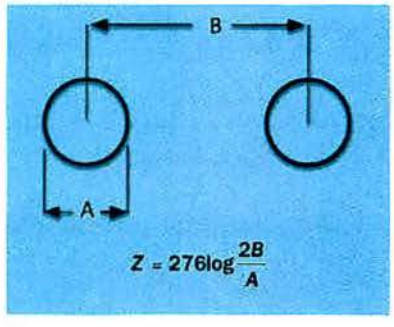


Figure 1. Balanced two-wire lines: formula for determining impedance of a two-wire transmission line. (*A* and *B* are the same units.)

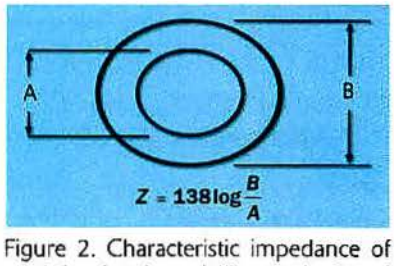


Figure 2. Characteristic impedance of an air-insulated *coaxial* line can be found by the above formula. (*B* and *A* are the same units.)

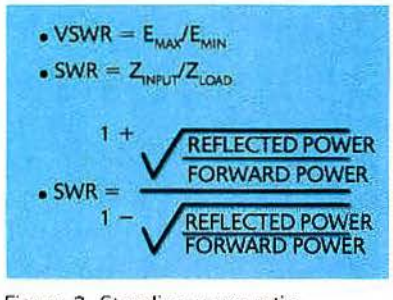


Figure 3. Standing wave ratio.

Transmission lines are either *balanced* or *unbalanced*. A two-wire transmission line becomes balanced when each conductor has equal impedance relative to ground or to its surroundings. An unbalanced transmission line has one conductor grounded, or exposed to the outside elements in greater magnitudes than the other conductor.

The impedance value is a function of conductor diameter and spacing between the two conductors. Impedance can be lowered by increasing the diameters, decreasing the spacing between the two conductors or both (see Figure 1). The most common balanced line impedances of today are 300Ω and 450Ω twin lead and 124Ω twinax (balanced coax cable). Seventy-five-ohm cable was common prior to the 1950s because most wire antennas were halfwave center-fed dipoles with impedances near 75Ω.

In an emergency, common 16 gauge lamp (zip) cord would suffice as a dipole transmission line. However, the sun deteriorates this type of cable when used for years at a time. Open-wire transmission line is more common for ham radio stations, not commercial or public safety facilities.

Coax cable

Co means "same or identical," and *axial-axis* means a "center point or point of common rotation." *Coaxial cable* is an unbalanced transmission line. Figure 2 shows the relationship of two conductors and the formula for determining the impedance of a coaxial line.

The center conductor must be kept evenly spaced inside the outer conductor, usually by a *separator*, or *media*. Common media include ceramic insulators (beads), spiral dielectric, polyethylene, fluorinated ethylene propylene-FEP (known as foam) Teflon and air or inert gas with separator beads.

Velocity factor

The media surrounding the center conductor slows the travel of RF energy. How much depends on the material used. The ratio of the time it takes for RF to travel through free space compared to the time it takes to travel through cable is called the velocity factor *vp*. The lower the value of *vp*, the longer it takes RF to reach the end of the cable. Common *vp* values are 0.66 for standard cable, 0.78 for foam, 0.82 for airfoam and 0.98–0.99 for air or inert gas.

All cables cut to a wavelength will be physically shorter than a free-space wavelength. For example, a halfwave at 150MHz is 39.36 inches. Using RG8/U cable, (*vp*–0.66), the physical halfwave cable length would be 39.36 × 0.66 =25.98 inches.

Velocity factors become important when coax cables are used to feed phased arrays and to interconnect cavities and duplexers. They

Buller is a special projects engineer for Tacoma Power, Tacoma, WA. For many years, he served as an electronics design engineer for the Washington State Patrol. He is a member of IEEE, NARTE, APCO and ARRL, and he is a Fellow of the Radio Club of America. His email address is *W7rqt@msn.com*.

are also important when a time domain reflectometer is used to find cable faults.

Impedance

A transmission line impedance can also be determined by $(L/C)^{1/2}$ or by Ohm's law, and would be found by measuring the voltage and current at the sending end of a line of infinite length. In practical terms, for cables shorter than infinity, an adjustable resistance can be added at the end and adjusted to a value that provides the same input voltage and current relationship of the infinite length. This value when measured, will equal the characteristic impedance of the line.

A second method for determining impedance is to terminate any length of cable in its characteristic impedance, resulting in no reflected energy. That way, maximum transfer of energy takes place. Any load connected to a transmission line with an impedance different from the line's characteristic impedance results in a standing wave pattern.

The input of cable measuring hundreds of wavelengths would have virtually no reflected energy and would appear to have an impedance input equal to its characteristic impedance. An example is 500 feet of RG58/U fed with 450MHz of energy. It would show an impedance of 50Ω and minimal reflected power because almost all of the energy would dissipate as it travels the length of the line. It would be an inexpensive dummy load.

The cable TV industry uses this concept in multiple distribution points where taps on the coax cable appear along the length of the cable. An amplifier supplying several volts of signal at the head end is sufficient to overcome the losses, and the loss of the cable terminates the amplifier.

VSWR

Voltage standing wave ratio was the first method for transmission line measurement. If the load absorbs all of the energy sent down the transmission line, no energy returns.

To measure this effect, a detector (often a voltage probe) is moved along the line, maintaining uniform distance from the line, noting the voltage change, if any, as the probe moves along and parallel to the transmission line. The change *Vmax/Vmin* equals the VSWR. The purpose of this test is to determine how closely the load matches the line. The distance between each voltage minimum equals the halfwave length of the transmission line frequency, not the applied frequency. This measured distance, compared to the applied frequency (wavelength), yields the velocity of propagation, *vp*. The movable probe method is used today mostly as a laboratory method and is most suitable when using the Smith Chart.

Determining SWR by reflected power

Today's methods for measuring forward power and reverse power at a point on the transmission line include:

- ❑ applying the formula shown in Figure 3.
- ❑ measuring forward and reverse power in dB and comparing the ratio of dBs, i.e. 25dB return loss.
- ❑ measuring power with a reflectometer and adding to the power reading the coupling loss of the device.

Reflected power is 180° out of phase from the forward wave as shown in Figure 4. To demonstrate this phenomenon, attach a rope or line to a fixed point, like a wall or doorknob, and with your wrist thrust a forward-looking wave. Note that immediately thereafter, a reflected wave will come back to you in the reverse mode. This demonstrates the principle by which directional couplers operate.

Figure 5 is a diagram of a directional coupler that consists of two short transmission lines in close proximity. Line *L2* is a transmission line that has its own characteristic impedance terminated by a resistor *R*. Power traveling in *L1* from left to right induces energy in *L2*, but this energy is dissipated in resistor *R*.

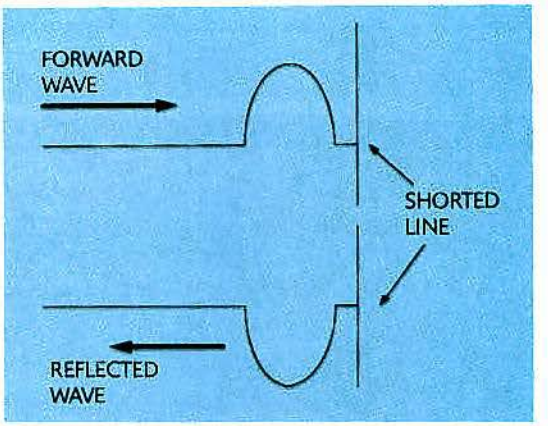


Figure 4. Reflected wave is 180° out of phase from the forward wave. It may lead or lag, depending on type of reactance load.

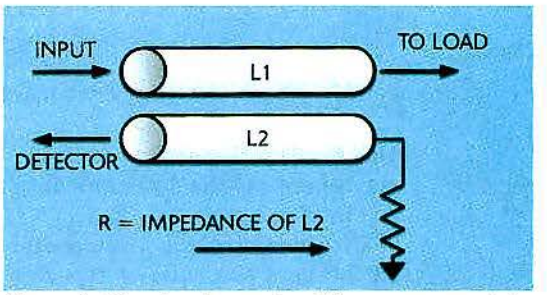


Figure 5. Directional coupler: This arrangement detects reflected power. Forward power can be measured by reversing power flow in *L1*.

If the load is not equal to the impedance of line *L1*, energy will be reflected back on *L1* and in turn coupled to *L2* and on to the detector. Reflected power in this example is measured.

If the input power and load were connected in reverse, the detector would then measure forward power.

If *L2* were physically reversed, keeping the input power on the left, forward power would then be measured.

This example explains how popular wattmeters operate. *L1* is the center conductor of the transmission line of the wattmeter. The rotatable slug is made up of *L2*, resistor *R* and a diode that connects to the meter calibrated in watts. Rotating the slug samples power in either the forward or reverse direction. Note

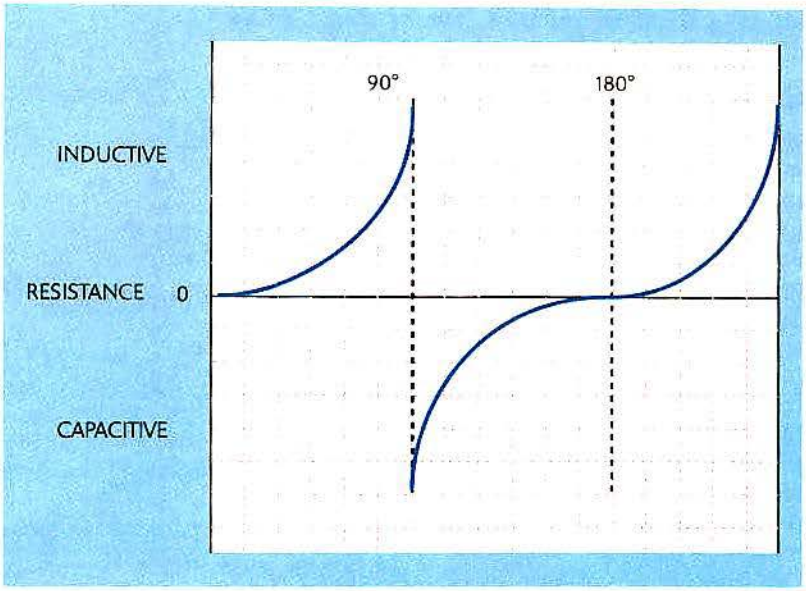


Figure 6. Graph showing shorted transmission line.

that the direction arrow on the slug corresponds to the detector side of *L2*, in Figure 5.

Directional couplers are useful in checking site noise or repeater de-sense. The benefit is that the reference signal generator is sent to the receiver, not to the antenna. Directional couplers are available from megahertz to gigahertz, the latter in the form of rigid waveguide components.

Transmission lines as stubs

A transmission line, when added to another transmission line in either series or parallel, can provide impedance matching. A transmission line that has a short circuit on one end will exhibit reactive components depending on its electrical length as shown in Figure 6. A quarterwave line shorted at one end has a high impedance at the opposite end—meaning it can be connected in parallel on a transmission line of the same impedance without affecting the line. If a halfwave shorted line were connected, the effect would be the same as placing a short on the transmission line at that point.

Another way of looking at this concept is that a quarterwave stub shorts out any second (or even) harmonic. All odd harmonics will be seen as high impedance.

Referring to Figure 6, the following can be stated: A short on one end of a quarterwave is open at the other end. A short on the end of a halfwave is a short at the other end.

The same result is observed when the cable is lengthened in any multiple of half-wavelengths.

The phase of the waveform shifts by 90° at a quarterwave, 180° at a halfwave and 360° at one wavelength of transmission line. Transmission line stubs can therefore be either open circuit, short circuit or terminated—all too often, *poorly* terminated.

Transmission lines as helpers

A length of open-end coax connected as shown in Figure 7A adds reactance according to its electrical length. Coax cable can be changed artificially by adding capacitive reactance to the open end of a stub to achieve the exact reactance desired as shown in Figure 7B. This short length of cable can be "tuned" by a variable capacitor connected between the center and outer conductor on the "open end" that electrically changes the cable length. The net effect is a series, low-impedance circuit connected at that point.

This is also a handy device for tuning a transmission line to measure what effect a cable would have when cut to the exact length. The capacity-tuned line is often used for tuning the coupling link of a cavity. It usually consists of a rigid

outer and center conductor with a movable dielectric that has the same effect as a variable capacitor.

A tuned cable connected by a "tee" can reduce interference when there is at least a 2:1 frequency difference between the desired signal and the interfering one. The bandwidth is a function of the diameter of the cable.

Transmission lines as transformers

The quarterwave transformer is useful for changing impedances. It can take the form of either a balanced line or a coax transmission line. Use the formula $Zline = (Za \times Zb)^{1/2}$, where Za is the impedance desired and Zb is the impedance to be matched. Combining two 50Ω impedances yields 25Ω. $(50\times25)^{1/2} = 35.5\Omega$ cable. This result can be achieved with two parallel 72Ω cables or with 35Ω cable. In either case, this 35.5Ω quarter-wave *electrical* length of cable connected to the parallel 50Ω devices transforms 25Ω to 50Ω.

Another way of solving the same problem is to change each of the 50Ω devices to 100Ω so that when they are connected in parallel, the net is a 50Ω point. The quarterwave cable would then have the impedance of $(50\times100)^{1/2} = 71\Omega$. Any of these methods can be used. They are found mostly in antenna-combining units where two or more antenna elements are combined to one 50Ω common feedpoint.

Another method of impedance matching is to make the quarterwave transformer out of rigid tubing. The trick is to find the right diameter for the center conductor. Using the previous example, here's how to find the right size for the hardware. Assume a quarterwave-long 35Ω transformer is desired, and we have a tube with an outer diameter of 1 inch, inside 0.78 inch. Use the formula of Figure 2 with Zo of $35 = 138\log B/A$ where B is 0.78 inch and A is found to be 0.435 inch. A 7/16 inch rod would serve the purpose.

The complete transformer will be a 3/4 inch pipe with a 7/16 inch diameter center rod with a coax fitting on one end of this coax line, and the opposite end will have two coax connectors in parallel to this quarterwave rigid pipe. The combination forms a matching transformer with high-power capabilities. These devices are listed in catalogs as *power splitters* or *hybrid combiners*. Now you know the secret to making your own, inexpensively.

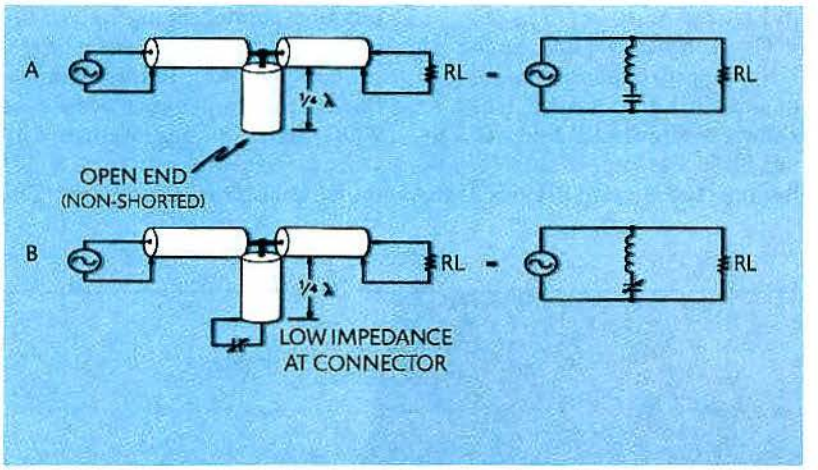


Figure 7a. Open-end stub: Not a complete open circuit, it has some radiation. 7b. Increasing capacity will lower frequency of low impedance. This method has a lower Q.

Balanced transformers

A further modification of the quarterwave transformer gives it a balanced output. If another larger diameter pipe were placed over this 1 inch pipe, say a 1 1/2 inch pipe (making the combination "triaxial"), and if it were grounded or connected to the feedpoint, the result would be a balanced 35Ω output because of the decoupling effect of the 1 1/2 inch pipe as shown

in Figure 8A.

Coax baluns (BALanced to UNbalanced) offer another method of obtaining balanced lines as shown in Figure 8B and 8C. Figure 8B is a 1:4 impedance step-up because the current divides at the junction point, leaving half of the total current feeding each line of the balanced port. In this example, the output impedance would be 200Ω. Figure 8C has no current division, therefore offers a 1:1 impedance transformation. The additional coax cable alongside converts the common ground point to high impedance because of the quarterwave transformation from a short to an open. These kinds of balanced transmission line transformers are effective tools in matching broadside arrays fed with coax cable.

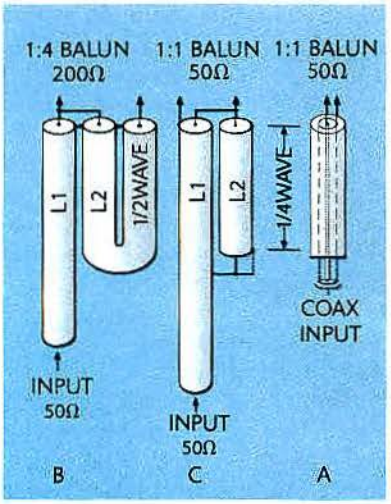


Figure 8. Coax balun. BALanced to UNbalanced. Z_L = L1 = L2, all cases.

With a basic understanding of transmission lines and some helpful tricks for using them as transformers and filters, you can configure feedlines properly and solve some problems along the way. ■

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CIRCLE (31) ON FAST FACT CARD

Time to stand up and be counted

Private land mobile radio and wireless dealers need to step up to the plate and defend their access to a finite natural resource: RF spectrum.

By Nick Ruark

Private land mobile radio and wireless dealers and RF system integrators may be a busy bunch today, but what about tomorrow?

Most of us operate small, independent businesses. We perform some or all of the marketing, sales, provision of technical services, customer and product support, billing and accounting typical of small businesses today. Is it any wonder that political advocacy often takes a back seat to our other responsibilities?

But we should immediately take steps to increase and defend our access to a finite natural resource, the RF spectrum. Too many of us seem to take it for granted, even as we depend on it to serve our customers' radio communications needs and to provide ourselves with an income and a living.

Many of us lack the time, the inclination or the perceived skills we believe are required to adequately express our interests. We simply sit back and accept whatever we get—or don't get—from spectrum battles waged by others. The problem is that others who are generally *not* part of the *private* radio and wireless industry are doing a good job of winning the public relations wars and the spectrum battles at the FCC—all at our expense.

Indifference and complacency on our part cannot continue. The time has arrived for the private radio and wireless industry to stand up and begin fighting back.

If we don't, we will remain near the bottom of the wireless pile as far as the public's recognition, perception and acceptance of what our industry can do for it is concerned. We'll continue to be at the mercy of whatever the "others" and the FCC think is best for us. Is this really what we want?

Come together ... right now

A large part of the problem is that the private land mobile radio industry suffers from fragmentation. We lack a single, strong voice that speaks on behalf of our little part of the overall wireless industry. We must come together, not necessarily as an association (because there are too many now, each with its own agenda), but as a strong, cohesive group focusing attention on the overall private land mobile radio and wireless industry in a way that would help to bring us together as a team.

Take cellular carriers, for example. They have a strong team. Yet, in the private radio and wireless communications industry, we are a lot of individual "islands" scattered around the country, operating independently and mostly without any coordinated or team approach.

In the private land mobile radio business, many of us have the experience, talent and expertise that helps keep the industry going. If it weren't for us, many advances in radio and wireless communications applications, efficiencies and technology wouldn't have happened. What prevents us from remaining in the forefront of the industry?

Several trade associations represent our industry, including the Small Business in Telecommunications, Industrial Telecommunications Association, American Mobile Telecommunications Association, Forest Industries Telecommunications, Personal Communications Industry Association, United Telecom Council and others.

Each does a good job of advancing its own agenda based on its own viewpoints; that's what any association should do. But their individual efforts on behalf of their membership fragments the team concept needed to effectively represent the overall interests of the private radio and wireless industry. Unless the associations can get together and work as a strong front on behalf of the entire industry (as they may do concerning Nextel Communications' 800MHz spectrum reallocation proposal), we're right back to square one.

The time has arrived for the private radio and wireless industry to stand up and begin fighting back.

With more than 25 years in this business, I value and respect the RF spectrum in a way that some may not. Too many, including the FCC and others, look at the spectrum strictly in terms of dollar signs, including the average return per unit or subscriber. This is wrong, and it will come back to haunt us.

Private radio and wireless is much more than dollars and cents. The many dedicated folks who work and contribute to this industry, our economy and their communities are not about to let this important area of wireless be steamrolled into oblivion by indifference, complacency or an attitude. Or are we? ■

Ruark is general manager of Quality Mobile Communications, a 25-year-old private radio/wireless communications sales, service and systems integrator in Vancouver, WA. His email address is *nbruark@qualitymobile.com*. Ruark hosts the Private Wireless Forum, an email and Web-based discussion group. To subscribe, send an email to *PrivateWirelessForum-subscribe@yahoogroups.com* or visit http://groups.yahoo.com/group/PrivateWirelessForum.

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J. Daniel ponders years of technology

My handset rang.

"Hello Jack? This is (noise ...) Bishop, and I wanted to know what you old (noise ...) think about the (noise ...) developments since (noise ...) went into business 20 years ago."

"??? Bishop?" I'm not Catholic, but ... *oh,* it must be "Don" Bishop.

"Old ???" I've been called an old ____ so many times and in ... *oh,* he probably said old-*timers.*

"??? developments?" I figured the missing word must be "wireless" (formerly "radio"), personal computers or safe sex. For Don, I chose "wireless."

"Since ??? went into business 20 years ago?" My old manufacturing company, Nova Electronic Systems? Speedcall? Vega? SEA? *Oh.* Another interest of mine at the time—*Mobile Radio Technology.*

Question decoded: "What's my view of the developments of the wireless industry over the last 20 years?" OK. Here goes.

a) No duplex handsets. We had to press a button to talk or "connect," and the transmissions were sent "direct" to everyone on the frequency. Then the industry developed billion-dollar duplex systems with no push-to-talk. But wait. Sprint PCS soon will offer PTT. Full circle?

b) Congested bands, sunspot "skip" and adjacent-channel interference. Good neighbors used isolators and filters. The FCC required the "last in" on a site to fix the interference they caused. That was business in those unenlightened days.

c) Coverage was great because—*no portable radios.* Most users didn't know coverage lacked in buildings, subways and parking garages because they didn't have the equipment to operate there.

"Quick, read back that list of wireless problems we used to have," crackles Don's voice through the hands-free earpiece—that I have to hold in place with my left hand.

I say: "No coverage; things that interfere; system designs have changed."

Don hears: "No (noise ...) things (noise ...) changed.

"I got it," Don says, as my battery fades. "Nothing's changed."

—Jack Daniel
The Jack Daniel Company
www.RFsolutions.com

Daniel is an editorial advisory board member and was the West Coast editor in 1983.

Uniden unveils P-25 scanners

Uniden Corporation of America, Fort Worth, TX, has released details about its plans to offer scanners capable of monitoring radio communications signals that use APCO Project 25 digital technology.

"Our retailers have been pushing us for a Uniden APCO 25 product for months, and our new BC250D hand-held and our BC785D base-and-mobile scanning unit represent the fulfillment of our promise. With the ability to monitor conventional, trunked and APCO 25 conventional and trunked systems these models are state-of-the-art radio scanners," Uniden Product Manager Scott Carpenter said.

According to Uniden representatives, the Bearcat BC250D and the Bearcat BC785D models would reach dealer shelves in late 2002. The products are designed to offer 1,100 channels, 10 banks and a frequency range of 25MHz–1,300MHz.

The new hand-held offers all of the features of Uniden's current BC780 XLT in a portable model, along with APCO 25 capability and an additional 600 channels. Users of both models would have to purchase an APCO 25 card, the BCi25D, separately, to activate the APCO 25 monitoring feature.

"We're pleased to be bringing these great Bearcat APCO 25 units to market," Carpenter said. "We expect more big cities to migrate to the APCO 25 digital technology, like Los Angeles did this past year, to ensure agency interoperability among police, fire, EMTs and the like. We know news organizations, businesses and consumers will want to monitor their signals."

Uniden officials stressed that APCO 25 digital scanning technology simply gives users the ability to monitor the day-to-day activities and signals of standard city and government service departments, but in no way allows users to monitor encrypted signals from national and local security organizations.

Kenwood supplies radios to Olympic team

The U.S. Ski and Snowboard Team has selected Kenwood Communications, Suwanee, GA, as its official supplier of radio communications equipment through 2004.

As part of the agreement, Kenwood will supply 160 of its model TK-380 UHF portable radios, as well as cases, chest packs, speaker mics, earphones and technical assistance. Athletes and coaches will use equipment during training and competition. The teams are part of the Park City-based U.S. Ski and Snowboard Association, which is the United States' Olympic governing body for all skiing and snowboarding.

About 50% of all sports at the 2002 Winter Olympics in Salt Lake City fall under the U.S. Ski and Snowboard Teams. The USSA sponsors six sports programs and 14 men's and women's national teams.

Motorola and ARINC form airport service

Based on Motorola's IDEN technology and Annapolis, MD-based ARINC's global communications networks, the ARINC Wireless Dispatch Service is a digital communications technology that offers more capacity than analog systems and direct coast-to-coast communications for airport workers.

This service supports communications at airline ground operations, airport operations, security services, airport vendors and service companies such as car rentals and transportation systems.

Newark International, Miami International and Los Angeles International are the first airports to use this service. Six additional airports are scheduled for installation.

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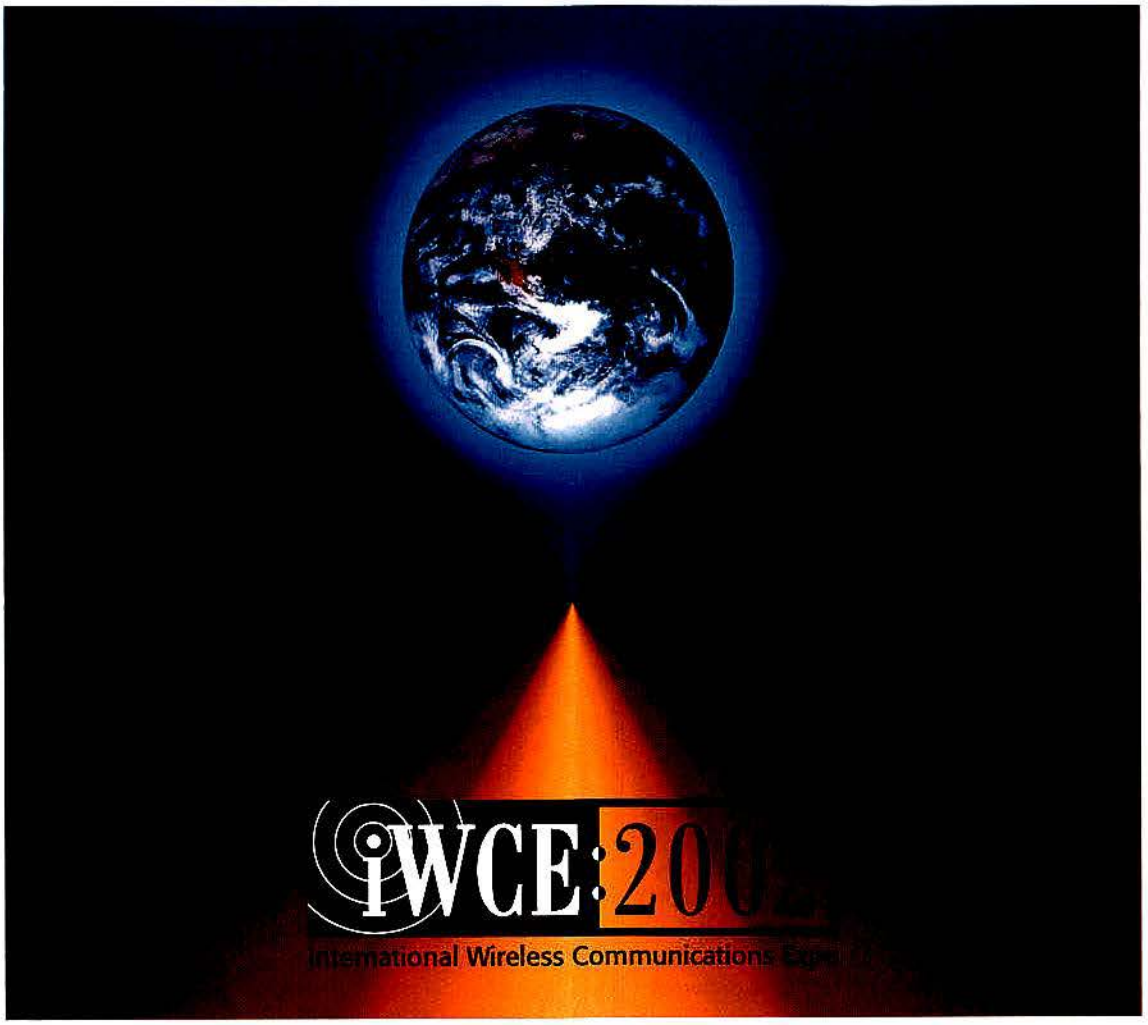

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Batteries, charger reduce memory effect

Motorola's Impres (intelligent Motorola portable radio energy system) is a series of replacement batteries and chargers. When they are used together, they can help eliminate "memory effect," which is caused by recharging a battery before the battery is fully discharged. The charger is three units in one: a rapid charger, a conditioning charger and a reconditioner. The battery features smart circuitry that allows it to transmit data regarding battery charge levels to the Impres charger.

WWW.MOTOROLA.COM

Replacement batteries are intrinsically safe

Multiplier Industries' rechargeable replacement batteries are designed for Ericsson/GE LPE series, MRK series, Motorola HT-750/1250, GP 350, P1225, Visar and XTS-3000 radios. To meet the needs of government agencies, fire departments, oil refineries and other organizations, these batteries are intrinsically safe and non-incendive.

WWW.MULTIPLIER.COM

Battery adapter supports Motorola radios

ITECH's NiCd and NiMH battery adapters are compatible with the Motorola Saber MX1000, MX2000 and MX3000 radios. The adapter uses the radio bayonet-type interface and reduces the need for multiple adapters to support multiple capacities. The battery part numbers BA1191 (NiCd only) and BA4018 (NiCd/NiMH) are compatible with the iQfive and iQplus analyzers and conditioners with software version 4.4 or higher.

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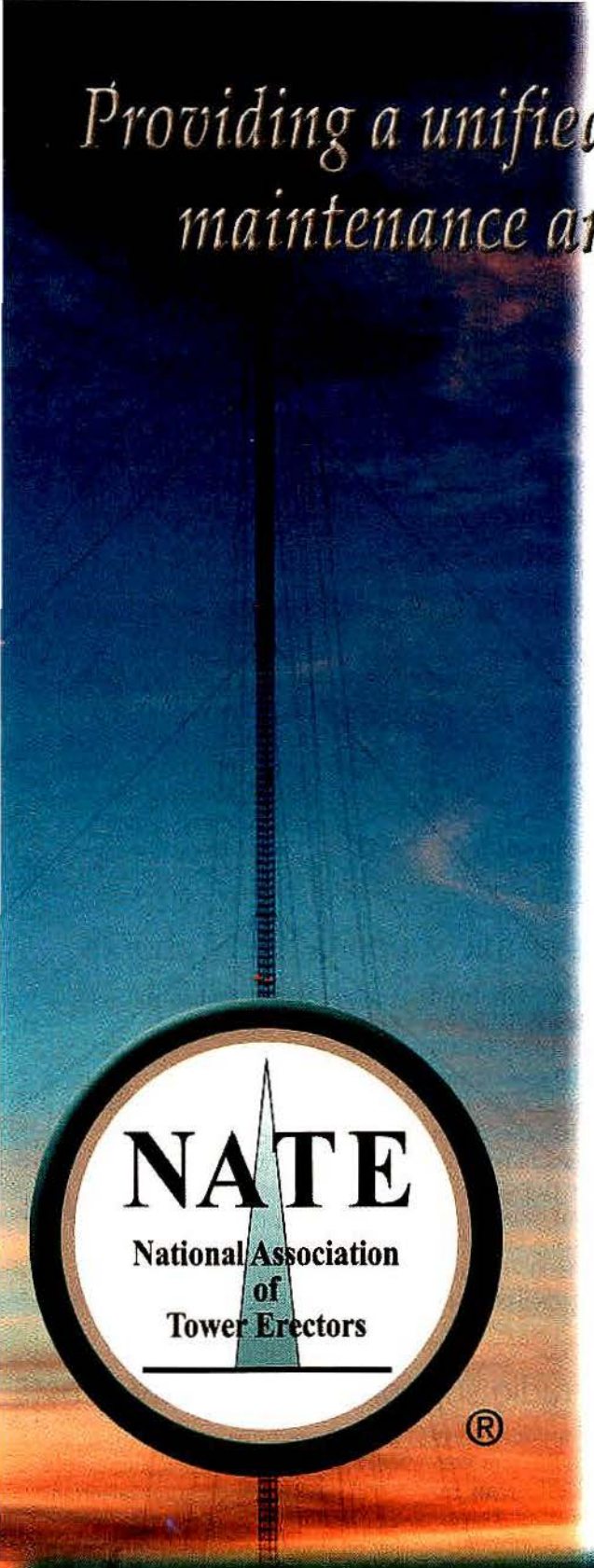

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Tower photo taken by and courtesy of Stuart Goettsch • SpectraSite Broadcast Group

Product Encore

Antennas mount on rooftops

The Telelocator dual-system antennas from **Antenna Specialists** combine active GPS location identification with broadband cellular for complete frequency coverage without tuning. The GPS engine includes a weatherproof ultrasonic seal to protect against extreme weather conditions. A single-cellular/GPS antenna is suitable for service providers who have added GPS positioning to existing cellular services.

WWW.ANTENNA.COM

Kit's grounding strap fits snugly on cable

Times Microwave Systems' grounding kits for its LMR-200 and LMR-240 series of flexible, low-loss coaxial cables are designated as GK-S200T and GK-S240. The kits come complete with a custom-fit ground strap, attached ground wire, lug-nut assortment and weatherproofing materials. The ground strap fits perfectly on the cable, so over-tightening the strap and damaging the cable, or having the strap adjusted too loosely and not having adequate grounding protection is avoided.

WWW.TIMESMICROWAVE.COM

Dispatch console provides system control

The ICP9000 radio dispatch console from **GAI-Tronics** can control as many as 12 conventional base radios. It is a compact console that supports multiple dispatcher locations. The unit is available in four (ICP9004A), eight (ICP9008A) or 12 (ICP-90012A)-channel configurations and expands for different needs. The console provides the dispatcher with complete system control. Standard features are the DTMF decode and paging encode.

WWW.GAI-TRONICS.COM

Industrial headset offers 24dB noise reduction

Klein Electronics and **Headset USA** have released a heavy-duty military-standard headset series: Titan. These industrial-strength headsets are rated for a 24dB noise reduction. The behind-the-head style enables usage of a hardhat, a safety helmet or a baseball cap. With available connectors, the headsets work with most Standard, Maxon, Motorola, Kenwood and Ericsson radios.

WWW.HEADSETUSA.COM

Remote speaker-mic supports IDEN phones

The remote speaker-mic from **CPR Technology** is available for the i85, i550 and i1000 IDEN phones. The RSM-1100 speaker mic operates as a conventional speaker mic with a PTT switch in the "direct connect" mode and as a hands-free "speaker-phone" in the cellular mode. Incoming cellular calls are answered by depressing the PTT switch on the RSM-1100. The mic can be used on one's person or in the vehicle. When used in the vehicle, plugging in the optional vehicle charger cord charges the phone's battery. The rear of the mic has a rotating clothing clip and a "hang-up-hook" for dash mounting.

WWW.CPRTECH.COM

Portable radio supports public safety apps

The VX-520 public safety UHF portable radio from **Vertex Standard** offers an intrinsically safe rating. The radio delivers 32 channels in the 450MHz–488MHz range. The wideband coverage ensures compatibility for programming in a wide variety of locations and applications. It features a four-character alphanumeric LCD on top of the unit. It contains a 16-position rotary switch and a programmable toggle switch for channel selection. The radio offers a dynamic priority channel, positive feedback action on the PTT and scan. It uses a large-capacity NiCd battery, which typically provides 11 hours of operating time. A full line of accessories complement these portables, including a choice of NiCd battery packs, chargers, mobile mounting bracket and speaker mic.

WWW.VXSTD.COM

Radio offers 250 UHF channels

ICOM America's IC-F4TR conventional radio is an LTR radio and a PassPort radio all in one. Features include 250 channels, 10 PC-programmable keys, display, scanning, CTCSS, DCS, DTMF encode and decode and reverse burst. A 40MHz bandwidth trunking feature allows for trunking channels far apart from each other.

WWW.ICOMAMERICA.COM

Repeater available in all levels up to 25W

The Eclipse 1U repeater from **RF Technology** is a 19" rack mounted repeater available in all levels up to 25W. It offers all the standard features of the current modules including a built-in speaker and microphone socket.

WWW.RFTECHNOLOGY.COM.AU

Wireless modem improves data rates

The Integra-TR integrated wireless modem from **Dataradio** is available in an FCC-certified 6.25kHz model. With as much as 5W RF output power in UHF or VHF, the modem provides over-the-air data rates of as much as 19,200bps in a 25kHz channel, 9,600bps in a 12.5kHz and as much as 4,800bps in a 6.25kHz channel. The modem allows access to the newest channels granted by the FCC refarming rules.

WWW.DATARADIO-COR.COM

ANI module supports Motorola, Ericsson radios

The ANI-M VX for Vertex handheld radios from **Midian Electronics** plugs into the VX-210A/400/600/800/900. The module can send ANI and emergency ANI in Motorola's MDC-1200, Ericsson's GE-Star, five-tone, DTMF or two-tone formats. The module offers features such as a programmable key-up delay, time-out timer and penalty time.

WWW.MIDIANS.COM

Conditioner charges batteries

AdvanceTec's negative pulse reconditioning charger and pulse analyzer conditioner is designed for two-way radio batteries. The battery can be charged and conditioned on a daily basis, keeping it at peak condition. This extends the life of the battery by as much as three times. When functioning as a negative pulse reconditioning charger, it uses inflection point cut-off as its primary termination method.

WWW.ADVANCETEC.COM

Connectors offer stainless steel

RF Connectors' RSA-3000-1B-03, SMA male and the RSA-3010-1B-04, right-angle SMA male crimp connectors are designed for use with RG-174/U and RG-316/U coaxial cables. Both feature stainless steel coupling nuts. The RSA-3000-B-SS and 3010-B-SS are straight and right-angle SMA male connectors.

WWW.RFINDUSTRIES.COM

Yagi supports SCADA applications

Antenex's YNT8063 yagi antenna is designed for SCADA applications. This 806MHz–866MHz three-element, 6.5dB-gain antenna is gold-anodized for corrosion resistance. Each element is fully welded to the boom. The driven element is a sealed folded dipole with a built-in balun transformer. Using high-strength 6061 T-6 aluminum, the antenna is designed to withstand the weather extremes of high winds, ice, snow and 100°+ temperatures.

WWW.ANTENEX.COM

Program aids law enforcement

New World Systems' Aegis hand-held Mobile Program allows law enforcement officials to conduct local, state and federal searches for information on people, vehicles and property by using a hand-held personal computer. Officers can conduct full-subject name, vehicle and property search inquiries while in the field. Used in conjunction with the company's Mug Shot software, officers can download and view mug shots on their hand-held PC.

WWW.NEWWORLDSYS.COM

Analyzer covers satellite L-band

The **Avcom-Ramsey Technologies'** PSA-45 and PSA-45DSI lightweight spectrum analyzers are used for antenna alignment and L-band signal monitoring. The analyzers feature dual input, which allows connection to two LNBs simultaneously. The LCD can show either LNB's output or both, side by side. The display is a high-contrast, 5.7" diagonal backlit LCD. The analyzer has frequency coverage of 950MHz—1,450MHz.

WWW.AVCOMRAMSEY.COM

Microwave radio features SONET

NEC America's Nlite 155 is a point-to-point digital microwave radio relay system that features compact SONET radio transmission equipment for the 6GHz, 11GHz, 18GHz, 23GHz and 38GHz frequency bands. The radio is designed to carry an OC3 or STM-1 (155.52Mbps). Applications include cellular networks, LAN/WAN connections, wireless SONET/ATM rings and Last Mile connection.

WWW.NECWAVE.COM

Pack Your Suitcase

February

19–22: NATE, sponsored by the National Association of Tower Erectors, Rosen Centre Hotel and Orange County Convention Center, Orlando, FL. Contact: 888-882-5865 or **www.natehome.com.**

19: AMTA "An Interactive Policy Forum for the Commercial and Private Wireless Industry: The Nextel 800MHz Proposal," BWI Airport Holiday Inn, Baltimore. **www.amtausa.org.**

26: AMTA "An Interactive Policy Forum for the Commercial and Private Wireless Industry: The Nextel 800MHz Proposal," Hyatt Regency at DFW International Airport, Dallas. **www.amtausa.org.**

March

13: Region 5 700MHz Planning Committee meeting, 10 a.m., Orange County Communications, Orange, CA. Contact: David Buchanan at 909-387-3337 or **www.cpra.org.**

18–20: CTIA Wireless 2002, sponsored by the Cellular Telecommunications and Internet Association, Orange County Convention Center, Orlando, FL. **www.ctiashow.com.**

April

7–10: ENTELEC, George R. Brown Convention Center, Houston. **www.entelec.org.**

23–24: British Association of Public-Safety Communications Officers, organized by Brintex, Novotel London West Convention Center, Hammersmith, London. **www.bapco.co.uk.**

24–26: International Wireless Communications Expo, co-sponsored by *Mobile Radio Technology*, Las Vegas Convention Center, Las Vegas. **www.iwceexpo.com.**

25: Simulcast Forum, Simulcast Solutions, Las Vegas Hilton, Las Vegas. **www.simulcastsolutions.com.**

May

6–10: Vehicular Technology Spring Conference, sponsored by IEEE, Birmingham-Jefferson Civic Center, Birmingham, AL. **www.ieee.org.**

15–17: 5th Annual PCIA Tower and Site Management Forum, sponsored by the Personal Communications Industry Association, Westin Diplomat Resort, Hollywood, FL. **www.pcia.com.**

20–23: ASCENT Spring Conference, sponsored by the Association of Communications Enterprises, Paris Las Vegas Hotel, Las Vegas. **www.ascent.org.**

June

2–6: Supercomm, sponsored by TIA and USTA, Georgia World Congress Center, Atlanta. **www.supercomm2002.org.**

16–20: NENA, sponsored by National Emergency Number Association, Indianapolis. **www.nena9-1-1.org.**

23–26: UTC Telecom, sponsored by UTC, the United Telecom Council, MGM Grand, Las Vegas. **www.utc.org.**

August

11–15: APCO Conference & Exposition, sponsored by the Association of Public-Safety Communications Officials–International, Opryland Hotel, Nashville, TN. **www.apcointl.org.**

September

17–20: PCIA GlobalXChange, sponsored by the Personal Communications Industry Association, Ernest Morial Convention Center, New Orleans. **www.pcia.com.**

October

5–9: 109th Annual IACP Conference: Law Enforcement Education Technical Exposition, Minneapolis. **www.theiacp.org.**

November

6–9: ITA Annual Conference, Marriott Wardman Park Hotel, Washington. **www.ita-relay.com** or 703-528-5115.

22: Radio Club of America Annual Awards Banquet and Technical Symposium, New York Athletic Club, New York. **www.radio-club-of-america.org.**

Editorial Index

Classifieds

Equipment for Sale

Employment

Equipment Wanted

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Computer Software

Rentals and Repairs

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Rentals and Repairs

Let's give credit where credit is due

You know I like to tell stories. Let me share another one with you. I'm a student of history. I have been since my undergraduate days. I am especially attracted to aviation history. Some of my fondest memories came from the fact that during my 20+ years in the Air Force, I was honored to meet many historical figures. In fact, while a student at the Air Force's Air Command and Staff College, I was part of a project to honor 25 aviation greats.

Five of us were "selected" (military term for "you just volunteered") to put together a program that resulted in a three-day event honoring the aviators. If there was a fun part of the program, it was that each of us got to select whom we wanted to come.

'I just flew the airplane. The real heroes designed the instruments.' —Jimmie Dolittle

As an electronics type (avionics officer), I wanted someone who had contributed to aircraft avionics. So, I nominated Jimmie Dolittle. Dolittle was an innovator besides being a war hero. He was the first man to demonstrate instrument flying was possible. The story behind how he did it is amazing. (There's a little homework for you.) Because of Dolittle, avionics became an integral part of flying.

When I met him, he was a frail man with a smile that would melt snow in Buffalo. I was awed at meeting him. I'm not usually shy or at a loss for words. Yet, when he walked in the room to meet with me, I couldn't say a word. He just reached out, grabbed my hand and said, "Hi. My name is Jimmie." It was all I could do to say, "Hi. My name is Roger." I was almost in tears being in the same room with him. It was just the two of us. He told me about his technology demonstration. He took off and landed without seeing outside the aircraft. He depended on the instruments in the aircraft. He risked his life to prove instrument flying could be done.

I was absolutely enthralled as he told his story. After he finished, I was able to muster a few follow-up questions and concluded by telling him that it was an honor to meet such an innovator, warrior and hero. He looked at me and said, "I just flew the airplane. The real heroes designed the instruments." What he didn't say was he was one of the designers. Here was a Medal of Honor winner being truly humble and giving credit to others.

Land mobile radio 'aviators'

I still get goose bumps when I meet or talk with someone who has made a difference in our way of life like Dolittle did. One such individual was Fred Link, whom I met only briefly prior to an RCA breakfast. Another was Al Gross, whom I didn't meet personally, but talked with on several occasions prior to his passing. I wrote a short article about Al for *MRT*'s sister publication *RF Design* and for the *Proceedings of the Radio Club of America*.

After writing about Al, I received several responses thanking me for the article. It was an honor to write about Al, so no thanks were needed. But some of the responses pointed out that there were others in the radio world such as Al (and Fred) who go unnoticed. Isn't that a sad commentary?

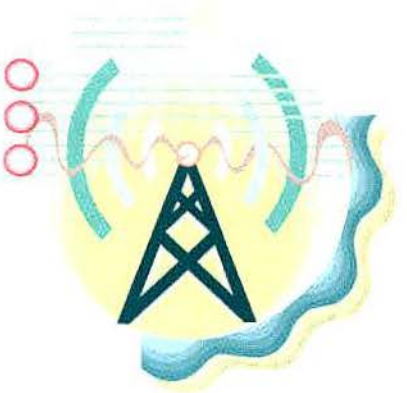
We depend on technology advancements to further the industry and seem only to live in the moment. We tend to forget those who went before. I want you to help me fix that. I want you to help educate me. If you know of someone who has made a difference in the world of radio, please drop me a note. It would be an honor for me to bring these individuals to the attention of the industry. Let's give credit where credit is due.

Viva Las Vegas

It's hard to believe that another year has gone by and we are on the verge of returning to Las Vegas for IWCE, April 24–26. This will be my fifth; for some it will be their 26th. This year's event promises to be outstanding. I've been assisting in putting the public safety track together, and I can tell you it will be exciting. While we are still firming things up, the topics will range from the events on Sept. 11 to Nextel spectrum issues. The other conference tracks are also shaping up to offer the kind of information you need to keep abreast of what is going on in the industry.

I look forward to IWCE every year. Of all the conferences I've attended, including military, aviation, security, electronic design and others, I find IWCE one of the most informative and just plain fun. Of all the industries I've had the honor to work with, I find no industry with a better sense of community than mobile radio. I look forward to seeing you in Las Vegas.

Editor
rlesser@primediabusiness.com



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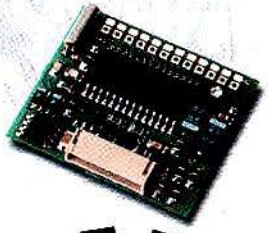

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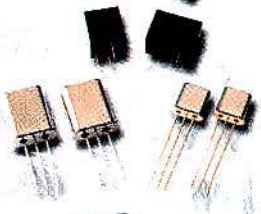

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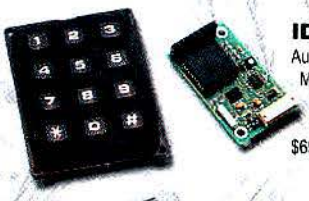

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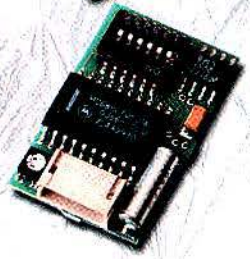

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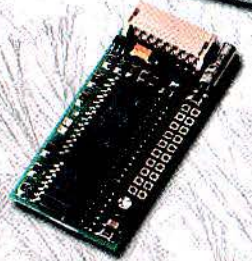

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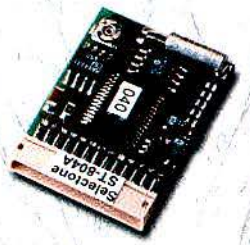

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